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ABSTRACT

This study tested two hypotheses: a) general principles underlying probability can be taught to young school children, and b) age differences influence one's ability to probability match (defined as the tendency to match reinforcement probability with response probability in a multiple-choice learning situation). In addition, the investigation explored two variables which affect a subject's ability to perform: the level of information feedback and length of anticipation schedules. Testing apparatus consisted of a stimulus-display panel with three push-plates; when a correct plate is pushed, the subject is reinforced with candy (child) or token (adult). First-grade children and college sophomores were both tested at three levels of information feedback, a single reinforcement schedule, and three trial-anticipation schedules. Subjects also responded verbally to questions which tested their awareness of probability. Analysis of data revealed a direct relationship between information feedback level and matching ability, with adults performing significantly better at lower feedback levels. As the length of anticipation trials increased, some age-related performance changes were also seen. It can be concluded that juveniles can process ambiguous content almost as well as adults if they receive a relatively constant and sufficient flow of information and if their storage capacities are not overtaxed. Most children also understood the probability involved. (LP)

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AGE DIFFERENCES IN INFORMATION PROCESSING OF AN AMBIGUOUS LEARNING TASK

Phillip C. Green
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Bowling Green, Ohio 43402

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Summary

The experimental literature contains several examples of studies which investigated developmental differences in mental capacities of children and adults. Although differences favoring adults have been often detected, it has become increasingly clear that children possessing mental abilities within the educable range are surprisingly capable of solving complex problems as long as they can grasp relationships expressed between the elements (problem) and the outcome (solution). An area which has received less attention, however, is the question of whether children are as capable as adults in solving problems based upon somewhat ambiguous elements and in which the principles underlying solution are similarly unstructured.

Within this conceptual framework a probability learning paradigm was used in the present research. This consisted of a three-choice learning task in which the outcome was randomly determined within the restriction of a pre-determined reinforcement ratio. Subjects were asked to predict which of the alternatives would be "correct" on any given trial in a series. Previous work using this paradigm had indicated a strong tendency for normal adults to demonstrate probability matching, that is, the tendency to asymptotically match response probability to reinforcement probability. Therefore, the main objective of the present work was to compare the ability of juveniles and adults to process the requirements of a multiple-choice learning task having an ambiguous solution, and in which task difficulty was varied. Two variables, the level of information feedback (IF) and a serial anticipatory procedure (AT) were used to assess task acquisition.

Apparatus consisted of a stimulus-display panel containing three push-plates. Triangle, square, or circle stimuli were superimposed, one on the plastic surface of each push-plate. Subjects were instructed to press one of these plates on each trial. If they pressed the "correct" one, a light came on behind the appropriate panel and either an "M" & "M" candy was dispensed to the juvenile subject or a token to the adult subject. Appropriate rewards for each age group were used to maintain optimal motivation levels throughout the lengthy trial sequence. Reinforcement schedules were monitored manually for juveniles and were automated for adults.

To get information for the main experiment, a preliminary study, using adult subjects, studied the

effect of five levels of IF (100, 80, 60, 40, and 20 per cent) on each of two reinforcement schedules (60:30:10 and 50:30:20 per cent). Separate subjects were tested under each condition and each was asked to anticipate outcomes over five consecutive trials (AT-5) before reinforcement information was delivered en bloc for those trials.

Results of this study indicated that: (1) As the IF level decreased, from 100 through 20 per cent, the ability of subjects to discriminate and, therefore, to match reinforcement levels under either 60:30:10 or 50:30:20 schedules decreased; (2) Below IF-80, the ability to discriminate reinforcement contingencies diminished rapidly on both reinforcement schedules and performance curves showed regression to chance levels (33-1/3 per cent); (3) Subjects were able to match the 60:30:10 reinforcement schedule better than the 50:30:20 schedule at higher IF levels, indicating that 60:30:10 was more discriminable than 50:30:20 and implicating discriminability level (DL) as another important variable in probability matching; and (4) Evaluation of the acceleration characteristics of the curves under the various IF levels suggested that, under these test conditions, little learning is possible if the feedback levels are 40 per cent or less.

On the basis of these findings, a second study, which compared performance of first grade school children (6-7 years old) with comparable groups of college adults on these variables, was initiated. Subjects, balanced for sex composition in both groups, were tested, respectively, on three IF levels (100, 60, 20), a single reinforcement schedule (50:40:10), and three AT schedules (2, 5, 10 trial blocs) in a counterbalanced design intended to systematically vary task difficulty.

Results of this study were essentially the same as in the previous one. However, the relationships between groups and among variables were complex and difficult to interpret. As before, a direct relationship was found between IF level and matching ability. Under the two-trial anticipation procedure, no essential difference was seen between juveniles and adults in matching ability under the IF-100 and 60 conditions. However, significantly better performance by adults was seen under IF-20, suggesting greater processing deficits by juveniles at lower feedback rates. As IF decreased, regression to chance levels by both age groups was seen to be about the same extent as for the previous reinforcement schedules.

As AT length increased, however, some performance changes between age groups were detected. Although it was found that adults could match reinforcement levels under AT-5 about as well as under the conditions tested in the previous study, juveniles under AT-5 showed significantly poorer matching ability on all three IF levels. On the AT-10 condition neither age group was able to match with any degree of precision although adults did somewhat better than juveniles on the IF-100 condition.

On the basis of these data, it was concluded that juveniles are capable of processing ambiguous content about as well as adults, if they receive a relatively constant and sufficient flow of information and if their memory capabilities are not overtaxed.

The main age factors which determine age differences in performance on this and similar tasks seem to lie, then, not in the absence of a functional processing mechanism in children, but rather in their information processing limitation as a function of information flow rate and capacity to retain in storage what has been previously experienced. This experimental paradigm did not permit the evaluation of the effect of prior learning with similar tasks (or their components) on processing ability, since this factor could not be controlled in human subjects. Therefore, an interaction between early experience and processing ability cannot be entirely ruled out. However, one of the original questions raised by this research -- can children be taught the rudiments of probability using this test paradigm -- was answered affirmatively.

Age Differences in Information Processing of an Ambiguous Learning Task

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A substantial literature has accumulated in the area of probability matching, which is defined as the tendency of a subject to asymptotically match reinforcement probability with response probability in a multiple-choice learning situation. A typical experiment in this area is one in which the subject is given two or more choice alternatives and is asked to guess which one will be "correct" on each of a series of trials.

In a classic experiment in this area by Grant, Hake, and Hornseth (1951), extending the experimental procedure first introduced by Humphreys (1939), the subject sat at a panel with two lights mounted on it, and was asked to guess, after one light went on, whether or not the other light would flash. The percentage of trials during which the second light flashed was predetermined at levels ranging from zero to 100 per cent. After approximately the first hundred trials, college student subjects tended to guess at about the same percentage at which the lights were flashing.

Hilgard (1956) in summarizing this research has stated that the results, although they seem reasonable, do not reflect the behavior one might expect from a "rational" decision maker, as implied in game theory. If one considers a case in which the light comes on, say, 75 per cent of the time and remains off the remaining 25 per cent, any gambler who knows that the odds are three to one in favor of one event occurring over the other will tend to maximize his chance of winning by always betting on the most frequent event. Yet, in these studies, the subjects somehow preferred to match stimulus outcome probabilities, leaving open the question of the variables involved in this somewhat paradoxical situation.

Although there have been few studies in this research area using children as subjects, the studies available indicate that a maturational factor is involved in performance differences seen between age groups. Jones and Liverant (1960), using children in various age groups, postulated that probability matching is associated with both previous experience and reinforcement contingencies. They found that preschool children tended to maximize the more frequent event while older children matched the probability of occurrence.

A similar study by Craig and Meyers (1963) indicated that preschool children make predictions of outcome below the probability of the more frequent event (non-maximizing). In a third study (Schusterman, 1963), three groups of children (ages 3.5, 5.1, and 10.8 years) were tested in a two-choice situation. Three-year-olds showed a strong "win-stay, lose-shift" strategy, five-year-olds were intermediate in this tendency, while ten-year-olds showed the greatest persistence in staying with an unsuccessful choice.

These findings indicate both the inconsistency of findings in the studies, and the probable interaction of a number of variables, including awareness and choice of strategy, discrimination of reinforcing events, rate of information flow, memory function, and maturational variables, to name a few. In the final analysis, the experimental literature seems to point not in the direction of a general probability matching theory, but to the identification and analysis of a great number of variables, all having different effects on the outcome of a particular experiment.

In a two-choice situation the subject always knows which of the alternative choices was correct on a given trial by virtue of there being only two alternatives. If he chooses one and it is correct, then the other must be incorrect, while the converse situation applies to the alternate possibility. In a three-choice probability paradigm, however, the subject may only know that he is correct if he chooses the correct alternative inasmuch as if he chooses an incorrect alternative, the resultant remains ambiguous. This paradigm, therefore, constitutes considerably less information than was present in the two-choice situation. An advantage of the three-choice procedure is that it is possible to more adequately manipulate the amount of information received by the subject as he progresses through each trial in the sequence. Since this procedure made itself so amenable to experimental manipulation of the amount of information transmitted over the course of the test procedure, two hypotheses were tested: (1) The first, an informal hypothesis, was to see if the general principles underlying probability could be taught to young school children using the experimental paradigm applied in this research; (2) The second, more formal, hypothesis was to investigate possible age differences in ability to match reinforcement schedules in a three-choice probability matching paradigm and to explore some of the variables which might influence the subject's ability to perform adequately under these conditions.

Previous work in this area (Green, 1966) had demonstrated that college students, when asked to select which one of three outcomes (stimulus cards, panel-mounted on push-plates) was "correct" (i.e., would light when pressed), tended to match the predetermined reinforcement schedules over a sufficient number of trials as long as they were given information concerning ongoing performance on each successive trial, thus corroborating the finding of matching behavior seen in the two-choice studies. The main objective of the present work was to investigate differences between juveniles and adults in their ability to process appropriately the requirements of a three-choice learning task having an ambiguous solution, and in which task difficulty was varied systematically. To this end, two main variables -- the level of information feedback (IF) and a serial anticipatory test procedure (AT) -- were varied to assess rate of acquisition on the learning task.

A portable test apparatus, measuring 18 in. high by 18 in. wide by 14 in. deep, was used to test all juvenile subjects at their respective schools. This unit consisted of a stimulus-display panel containing three push-plates, 6 in. square, and located horizontally on the panel. Stimulus cards each containing a triangle, square, or circle, were permanently superimposed on the plastic surface of the push-plates. Subjects were instructed to depress one of these plates on each trial. If they made a "correct" response, a light came on behind the appropriate plate and an "M" & "M" candy was delivered through a candy dispenser, accumulated throughout the test sequence, and used to exchange for toys at the end of the test session. The apparatus used for adult testing was physically almost identical to that used for juvenile testing except that it was fully automated. Paper punched program-tapes were cycled through a Friden tape recorder unit and subjects' responses were recorded on data tapes by a Friden paper-tape punch. Instead of maintaining motivation with candy, a token dispenser was used and each token accumulated at the end of the test session could be redeemed for one cent. Appropriate rewards for each age group were used to maintain optimal motivation levels throughout the lengthy trial sequence. Equal numbers of male and female subjects were used in testing each age group.

To get information on optimal test procedures as well as appropriate test parameters, a preliminary study, using college students as subjects, studied the effect of five levels of IF (100, 80, 60, 40, and 20 per cent) on each of two reinforcement schedules (DL = 60:30:10 and 50:30:20 per cent). For example, a subject being tested

under the DL = 60:30:10 schedule could receive a maximum of 60 triangle, 30 square, and 10 circle stimulus reinforcements out of 100 trials. If he were working under the IF = 100, AT-5 condition, he would anticipate trial outcome by responding five times, being fed back information on those trials, anticipating the next five, being fed back information on those trials, and so forth. If he were working on an IF-80 schedule, instead of being fed back information on all trials, for each block of ten consecutive trials (two AT blocks), two of those trials would be blank or non-information trials, under IF-60, four trials of ten would be blank, and so forth.

Separate subjects were tested under each condition. Each subject was instructed to anticipate reinforcement outcomes in five-trial blocs (AT-5) before reinforcement information was delivered to him en bloc for those trials until a total of three hundred trials had been run on each subject. The experimental design for this study is shown below (TABLE 1):

Information Feedback Level (IF)	Reinforcement Contingency (DL)	
	DL_1 = 60:30:10	DL_2 = 50:30:20
100	N = 25	N = 25
80	25	25
60	25	25
40	25	25
20	25	25

TABLE 1. Experimental Design For Study 1.
(5-trial Anticipatory Response Procedure)

Results of this study (See Appendix) clearly showed that: (1) As the level of information decreased through the five levels of IF (100 through 20 per cent), subjects were increasingly unable to match the reinforcement levels under either 60:30:10 or 50:30:20 DL schedules within the same total number of trials. Since asymptotic performance levels were apparently reached well before the three-hundredth trial, it was assumed that inability to match was a function of an information processing

limitation rather than due to some artifact such as an insufficient number of trials; (2) Although between the 100 and 80 per cent feedback levels only a small decrease in matching ability was seen, below IF = 80 per cent the ability to discriminate the same reinforcement contingencies was noticeably impaired on both reinforcement schedules and performance curves tended to show regression to chance levels (33-1/3 per cent); (3) Subjects were able to match the 60:30:10 schedule better than the 50:30:20 schedule at the higher IF levels, suggesting that the 60:30:10 schedule was more discriminable than 50:30:20 and implicating information discriminability as a potentially important variable, not only in probability matching, but more generally in information processing; (4) Evaluation of the acceleration characteristics of the learning curves under each of the five IF levels indicated that, under these experimental conditions, little improvement in learning is possible if the IF levels are 40 per cent or less.

A repeated measures analysis of variance (Edwards, 1956) was performed on the data to evaluate main effects and interactions. As was expected, the correlated main effect, Trials, was significant ($p = .01$), as was the uncorrelated effect, IF levels ($p = .01$). Further tests of differences among IF levels corroborated prior expectations based on visual inspection. For DL = 60:30:10, significant differences in slope were found between the two highest IF levels (100, 80) and the three lowest levels (60, 40, 20), thus providing statistical evidence for differences in information processing ability at these levels. For DL = 50:30:20, the only significant slope differences encountered were between the four highest IF levels (100, 80, 60, 40) and the lowest level (20), doubtless accounted for by the fact that since discriminability was less at this DL, matching was poorer throughout this series and, therefore, performance differences were smaller from one level to another.

On the basis of these findings, a second study was initiated, which compared the performance of first-grade children (6-7 years old) with comparable numbers of adults (college sophomores), both groups balanced for sex composition, on these variables. In this case, subjects in both age groups were tested on three levels of IF (100, 60, 20) which bracketed the values used in the previous study, a single reinforcement schedule (DL = 50:40:10), and three trial-anticipation schedules (AT = 2, 5, 10 trials). These conditions were designed to systematically vary task difficulty, as shown below in Table 2:

Information Feedback Level (IF)	AT Level	N
100	2	25
100	5	25
100	10	25
60	2	25
60	5	25
60	10	25
20	2	25
20	5	25
20	10	25

TABLE 2. Experimental Design for Study 2. (DL = 50:40:10) Both age groups were run through this design.

At each feedback level, separate groups of subjects were asked to anticipate expected outcomes in blocks of either 2, 5, or 10 trials. They were then fed back information with the appropriate blank (no information) trials inserted. In the case of juvenile subjects, a portable test apparatus was used at the school which the subject attended. Subjects were brought into a separate test room during a free period, instructions were couched in terms of a set of game rules, and then it was explained that they would receive a candy "M" & "M" for each correct guess. A box containing a large array of inexpensive toys was opened for their inspection and they were told that after the game was completed, they could, depending on how many pieces of candy they won, trade in the candy for a toy (in reality, all subjects were allowed to choose and keep two toys, regardless of how many trials they guessed correctly). During the game, frequent brief rests were given during which time the observer asked a set of short standardized questions about the game to determine whether the subjects were aware of the probability principles involved. Responses were rated and recorded on protocol sheets immediately following each test session. It was generally agreed by all test personnel that motivation levels were kept noticeably higher than they had been observed to be in previous pilot work. There were several cases in which subjects in this age group, being run on the IF-20 condition, verbally expressed some distress at the low feedback rate, but no subject failed to complete the entire test sequence.

Adult subjects were tested, two subjects per session, on an automated version of the portable test apparatus. The physical dimensions of the test panel and the spatial relations of the push panels containing the test stimuli were almost identical with the other unit except that the dispensers mounted on the adult version delivered red tokens instead of candy. Subjects were given an almost identical briefing and were then told that each token won could be exchanged for one cent at the end of the test session. Here again, questions were asked concerning game principles during brief rests interspersed at about the same points in the testing and motivation levels were observed to be high throughout testing, with the exception, again of several instances of expressed dissatisfaction concerning lack of sufficient information under the IF-20 condition.

The results of this study (See Appendix) were similar to those seen in the previous study. However, since the design was more complex, the relationships between groups and between variables were sometimes more difficult to interpret. As before, there was seen a direct relationship between the IF level and matching ability. In both age groups, under the two-trial anticipation procedure, no statistical difference was seen in matching ability under the 100 and 60 per cent IF conditions. However, significantly better performance by adults occurred under IF-20 ($p = .05$), suggesting a greater processing deficit by juveniles at lower feedback rates under the conditions of this study. Again, a systematic regression toward chance response levels by both age groups was seen as feedback was reduced, to about the same extent as had been seen for previous reinforcement schedules. No differences were measured as a function of sex composition of the groups at the various age levels, although there was some suggestion that female juveniles were better able to verbally express the probability concept than were males in the age group used in this study.

As AT length increased, however, some age-related performance changes were observed. First, although it was found that adults could match reinforcement levels under AT-5 about as well as they had done under the conditions tested in the previous study, juveniles showed significantly poorer matching ability on all three IF levels ($p \leq .05$). On the AT-10 condition, neither age group was able to match reinforcement contingencies with any degree of precision, although adults did somewhat better than juveniles on the 100 per cent IF condition.

An analysis of variance applied to these data showed results similar to those encountered previously. Under AT-2, however, although there was a progressive decrease in matching ability under decreased IF of both age groups, the IF main effect fell short of significance indicating that, overall, both age groups found this DL schedule easier to process at the AT-2 rate. At both AT-5 and AT-10 conditions, a highly significant IF main effect ($p \leq .01$) was obtained. This effect was most clearly seen under AT-10, but the Between Age Groups effect was highly significant ($p < .05$) on both AT conditions. As before, the "Trials" effect was highly significant on IF-100 and IF-60, but fell short of significance on IF-20. As expected th interaction, IF X AT X Age Groups was significant ($p = .05$) presenting statistical support for the clear graphic evidence that the ability for different age groups to process the ambiguous task presented in the experimental paradigm under a processible DL is a function of the amount of information feedback under a given trial anticipation level.

On the basis of these data it was concluded that juveniles can process ambiguous content almost as well as adults if they receive a relatively constant and sufficient flow of information and if their memory storage capacities are not overtaxed as they process the inflow. Therefore, the main factors which determine age differences on this and similar tasks within the probability matching paradigm seem to lie, not in the absence of a functional processing mechanism at a given level of maturation in children (although on the basis of this data, one cannot say with assurance that this mechanism exists in children before the age of six years), but rather in their limitations in information processing as a function of rate of information flow and in their capacity to retain in storage what has been previously experienced and to apply this information to new inputs. The processing aspects of this task seem to contain the elements of the learning-to-learn phenomenon which Harlow (1949) has described in his research on monkeys and other mammals. The task used in the present study is different, however, in that the learning set literature places emphasis on a definable problem with a predetermined solution. In that sense the ambiguity level of the present task is greater since it relates a probabilistic and, therefore, relative solution rather than an absolute one. This experimental paradigm was also somewhat limiting in that it did not permit evaluation of the effect of prior learning with similar tasks, or their components, on processing ability, since this factor could not be controlled in human subjects. Therefore, a possible interaction between early experience and processing ability

cannot be ruled out. However, one of the practical questions raised by this research -- can children be taught the rudiments of probability using this test paradigm -- was answered affirmatively. In the protocol data, when children were asked whether they understood what was happening, 85 per cent (90 per cent females and 80 per cent males) of the group gave answers which indicated that they had at least a rudimentary grasp of the way in which probability functioned in this situation.

As is the case with much inceptive research, more questions are asked than are answered by these studies. For example, it is still poorly understood just how children (as well as adults) are able to process what seems intuitively to be a difficult task because of the high ambiguity level. Can this processing be done consciously or without awareness? Must a critical amount of information be received before processing can be successfully accomplished, or does the brain require a certain amount of information presented per unit time? Finally, are there critical maturational components involved in the successful processing of this type of problem and, if so, what are these maturational points?

These questions, and many more, are yet to be answered by this type of research before we can understand more fully the intellectual capabilities of the developing human organism.

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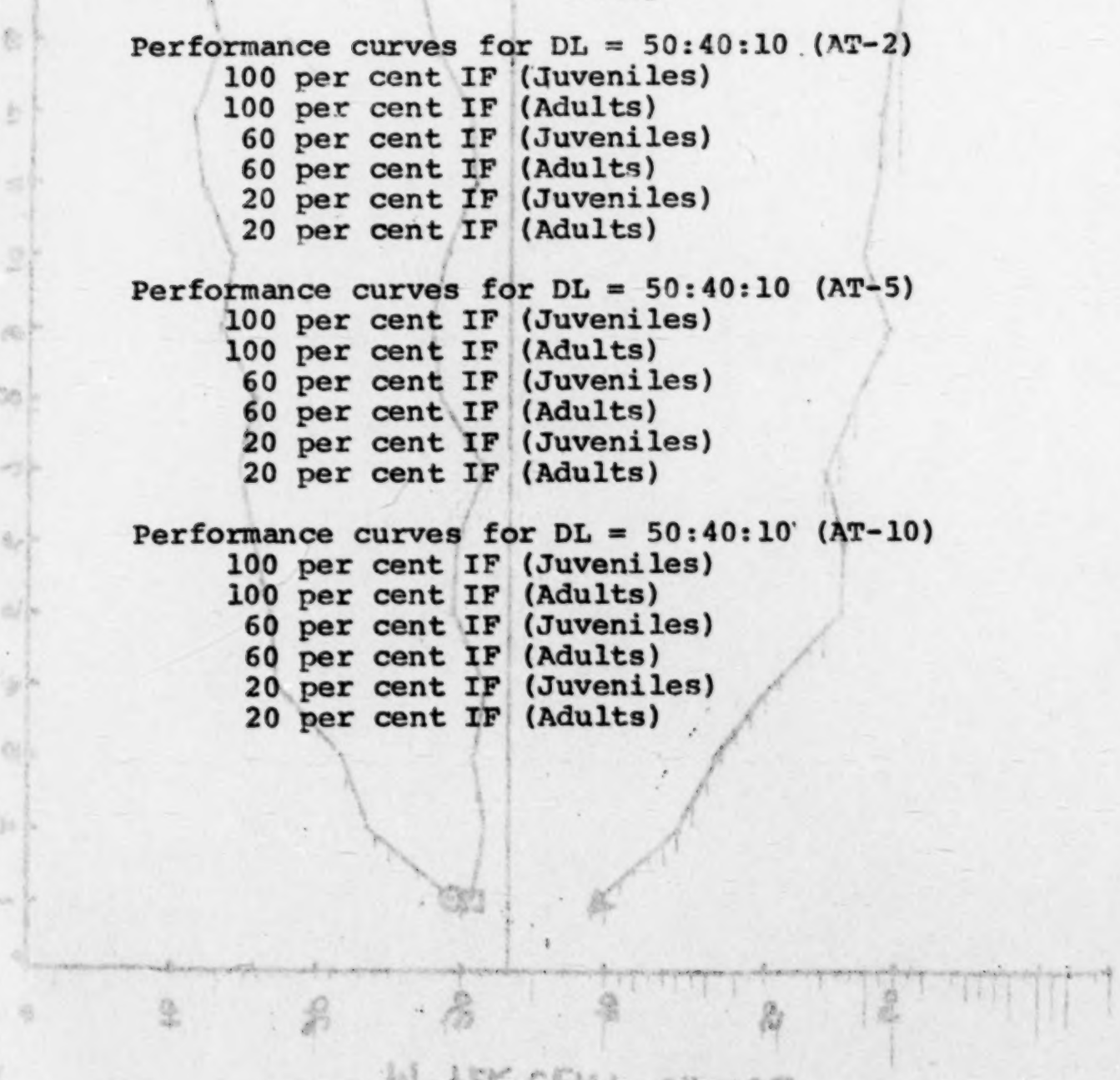

100 % FEEDBACK
5-trial anticipation pred.

DL 60:30:10 △ □ ○

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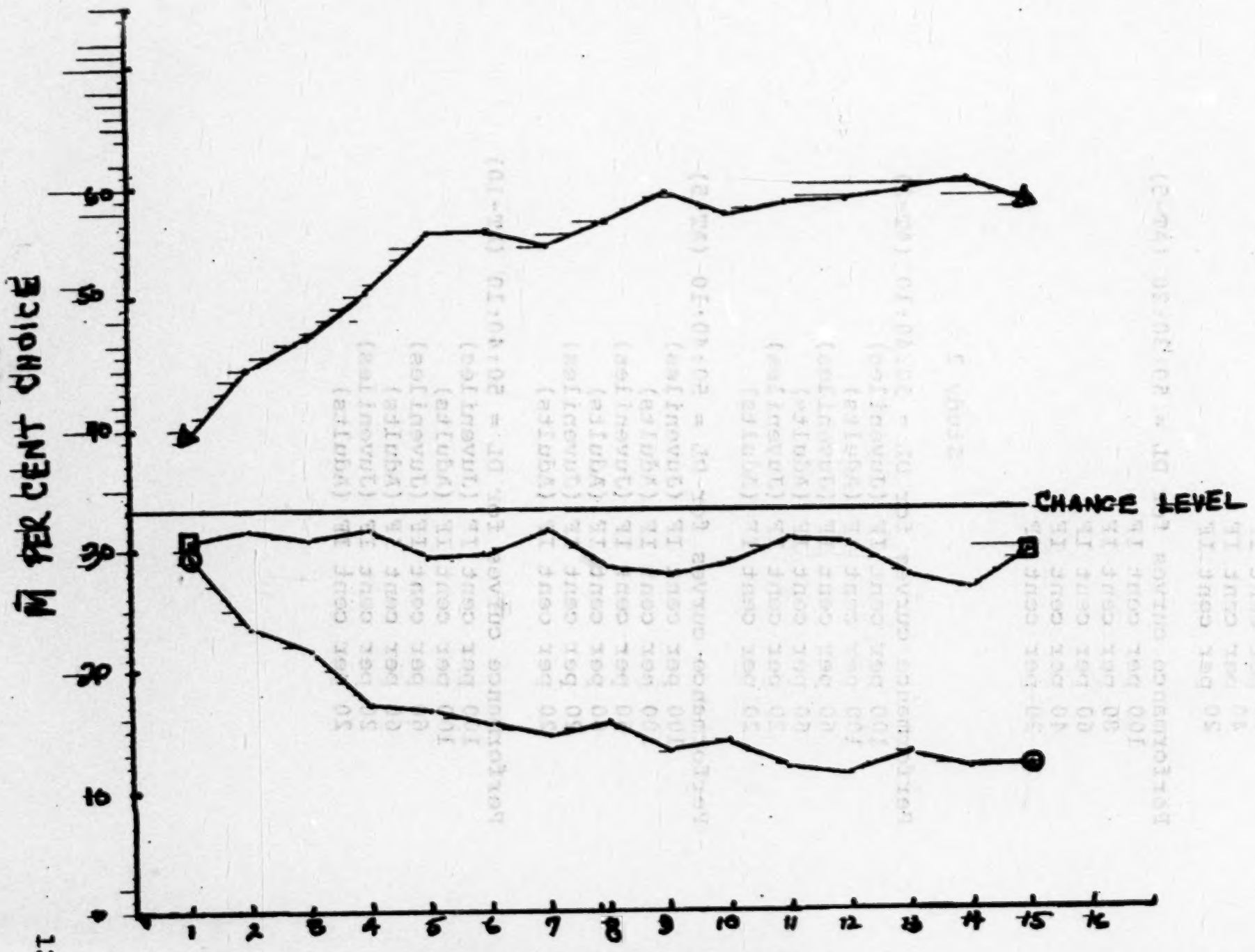

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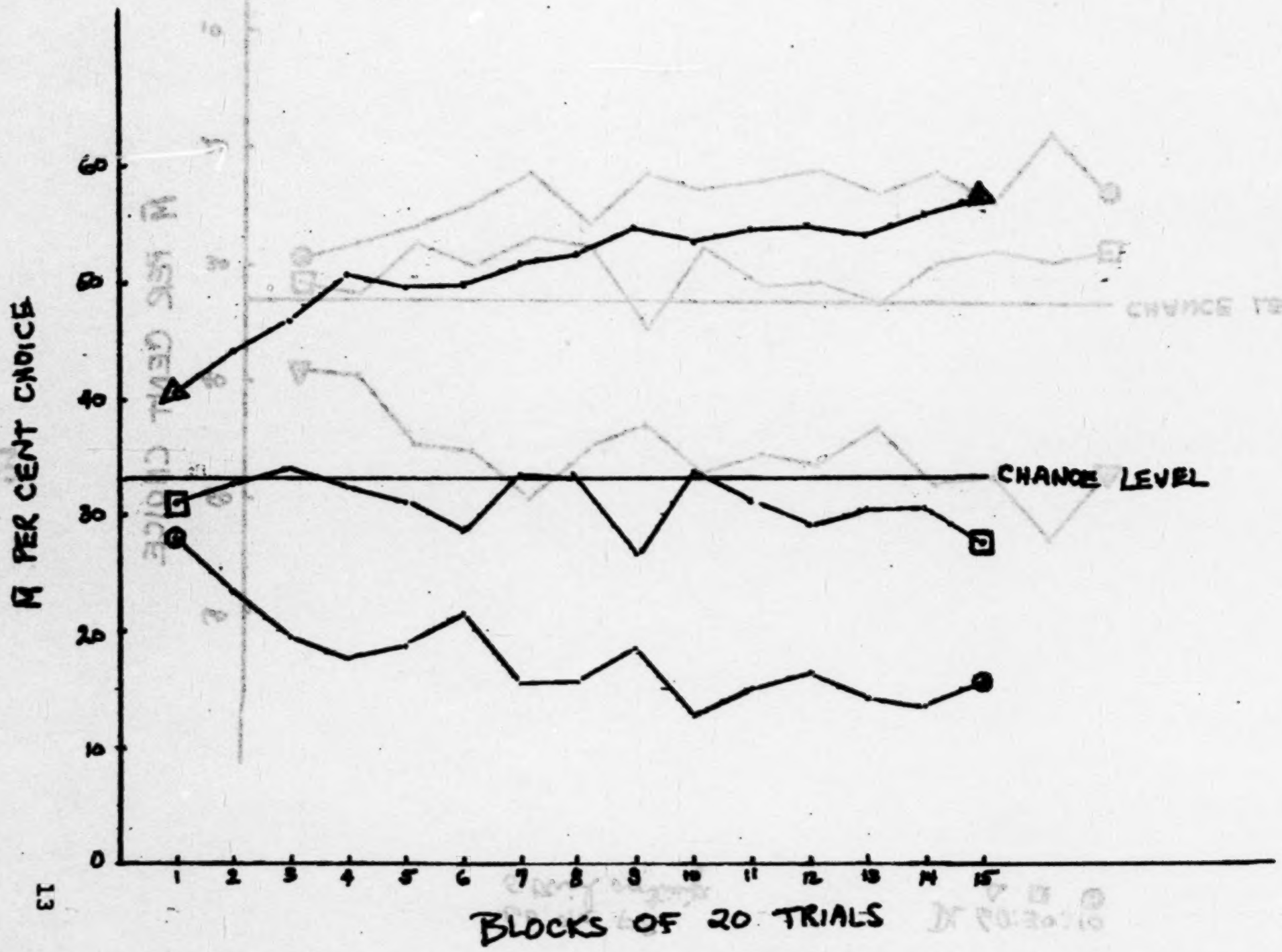
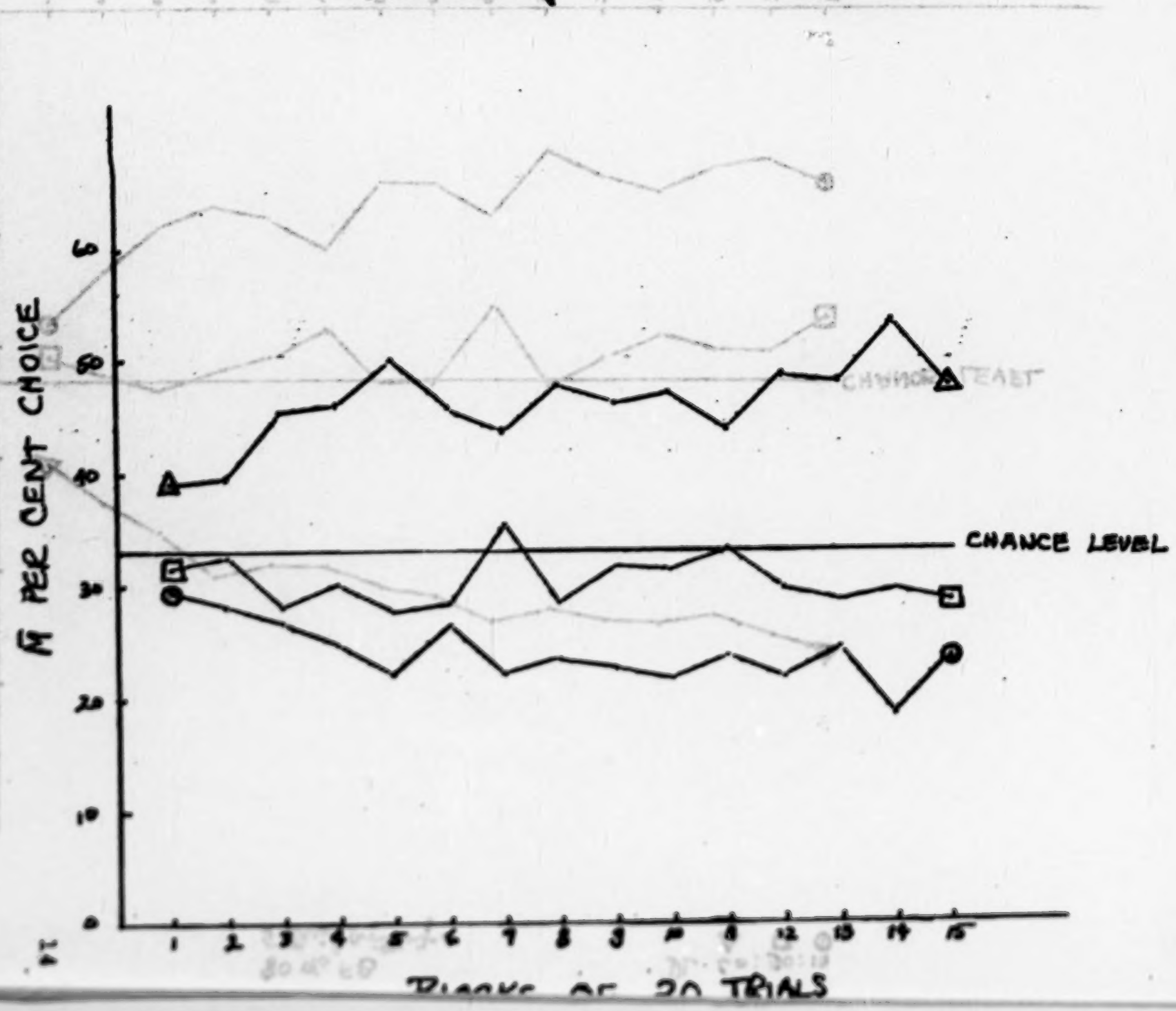
5-trial anticip.

DL 60:30:10
△ □ ○



60 trg FB
5. trial antiap

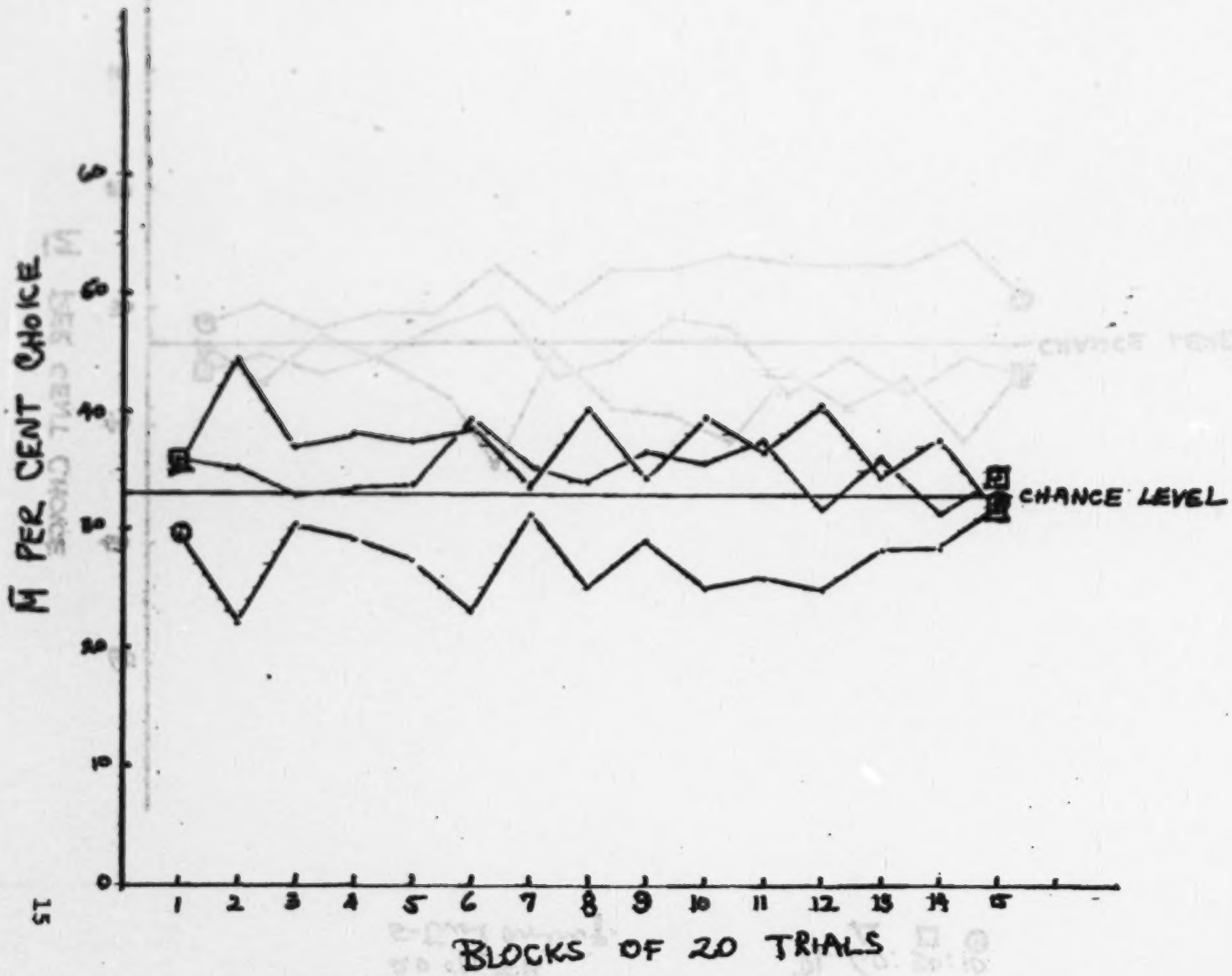
DL 60:30:10
△ □ ○



40 To FB
5 trial anticip.

DL 60:30:10
△ □ ⊙

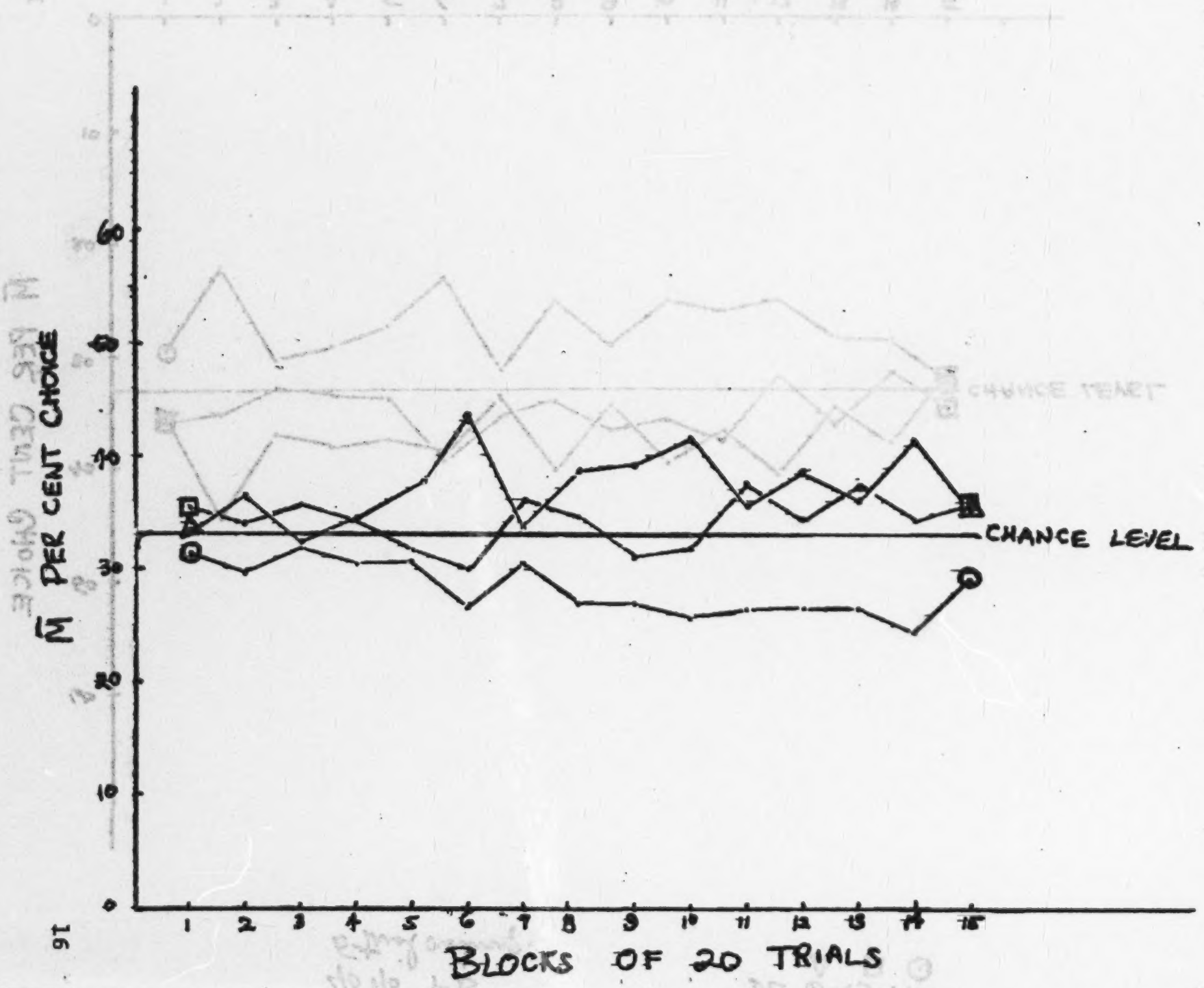
LELL



20 % FB
5-Trial antic.

DL 60:30:10
△ □ ◎

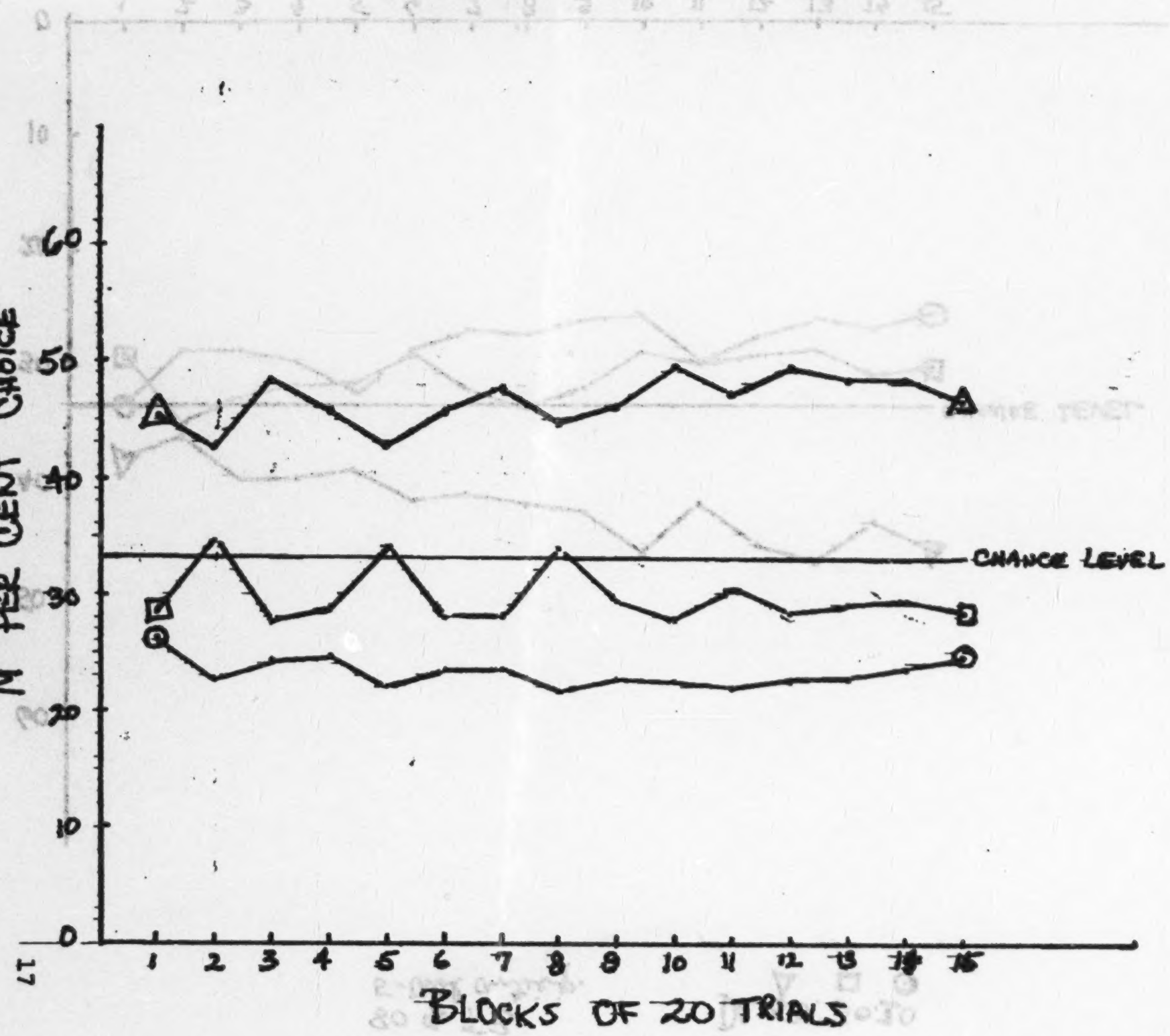
LELL



100 % FB
5-trial antic.

DL 50:30:20
△ □ ⊙

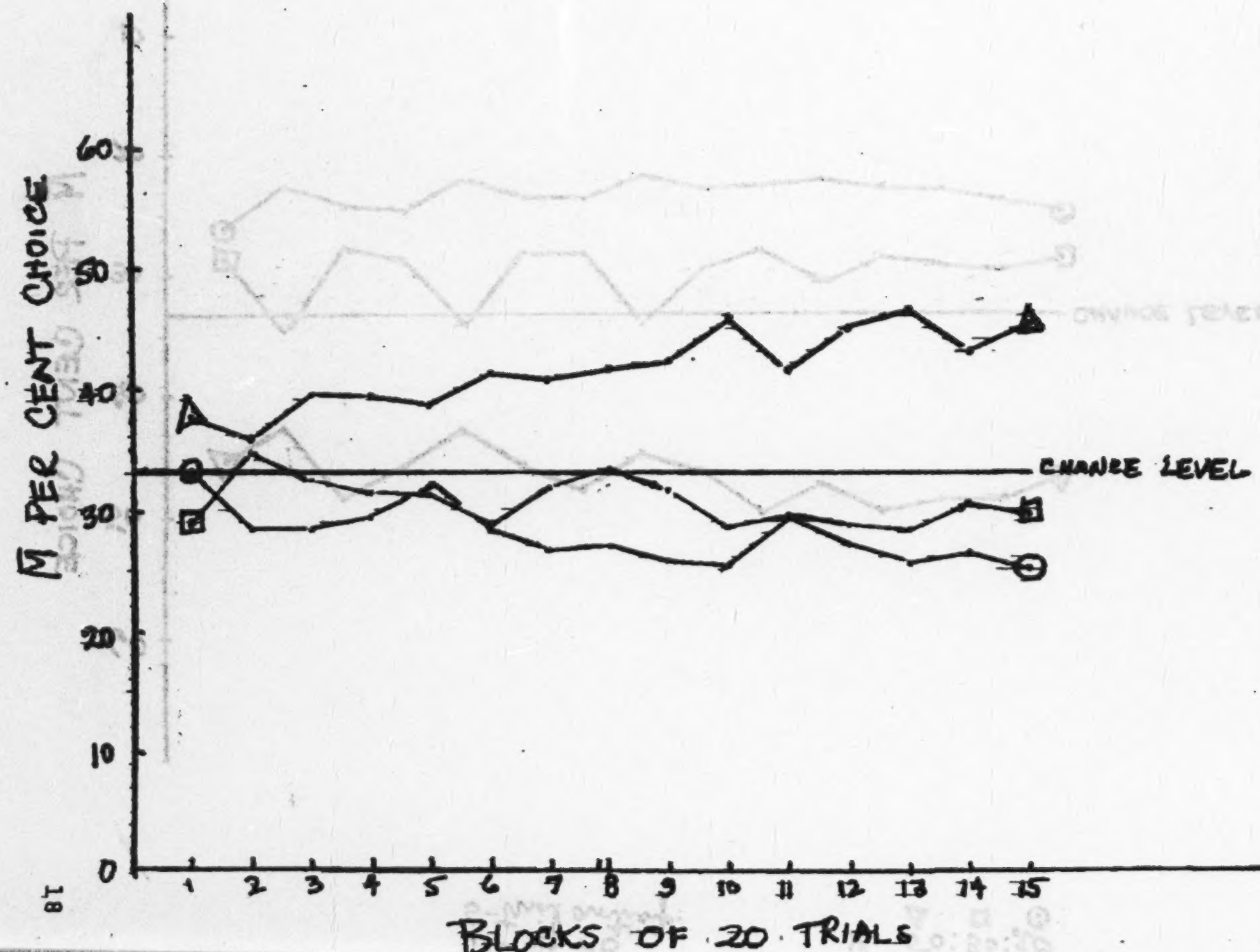
LELL



80 % FB
5-Trial anticip.

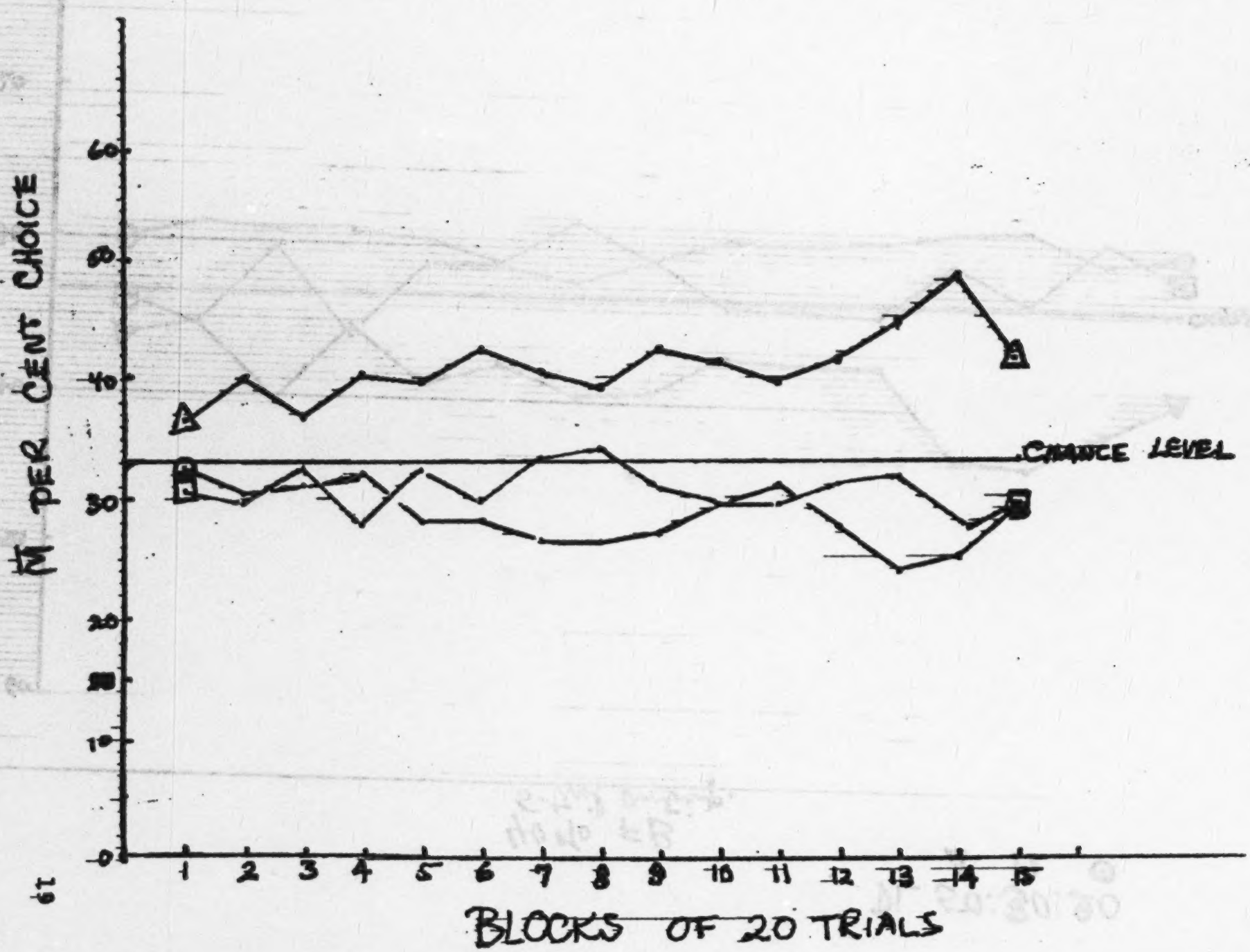
DL 50:30:20 △ □ ⊙

LELL



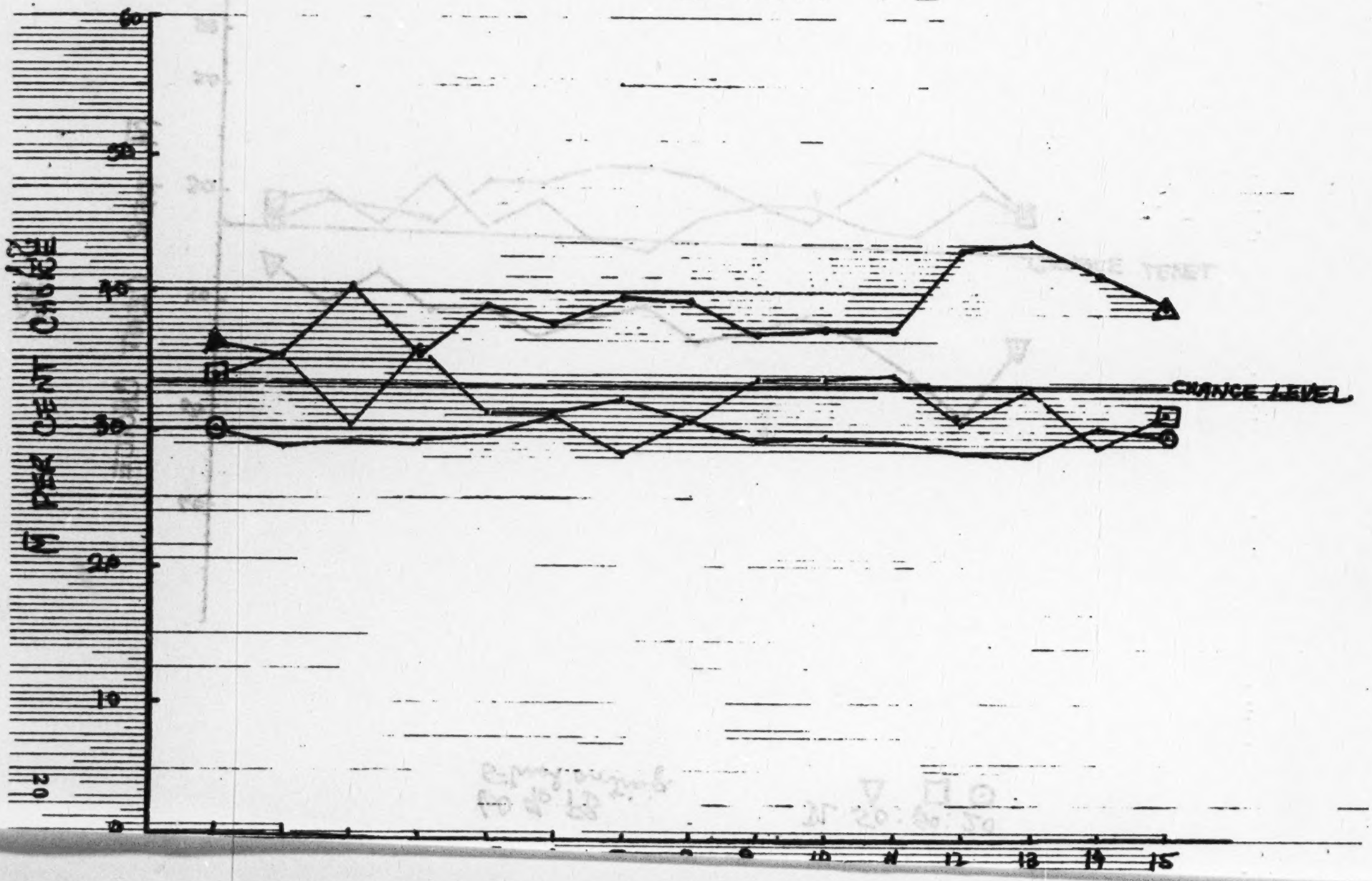
60% FB
6-trial anticip.

DL 50 : 30 : 20
△ □ ⊙



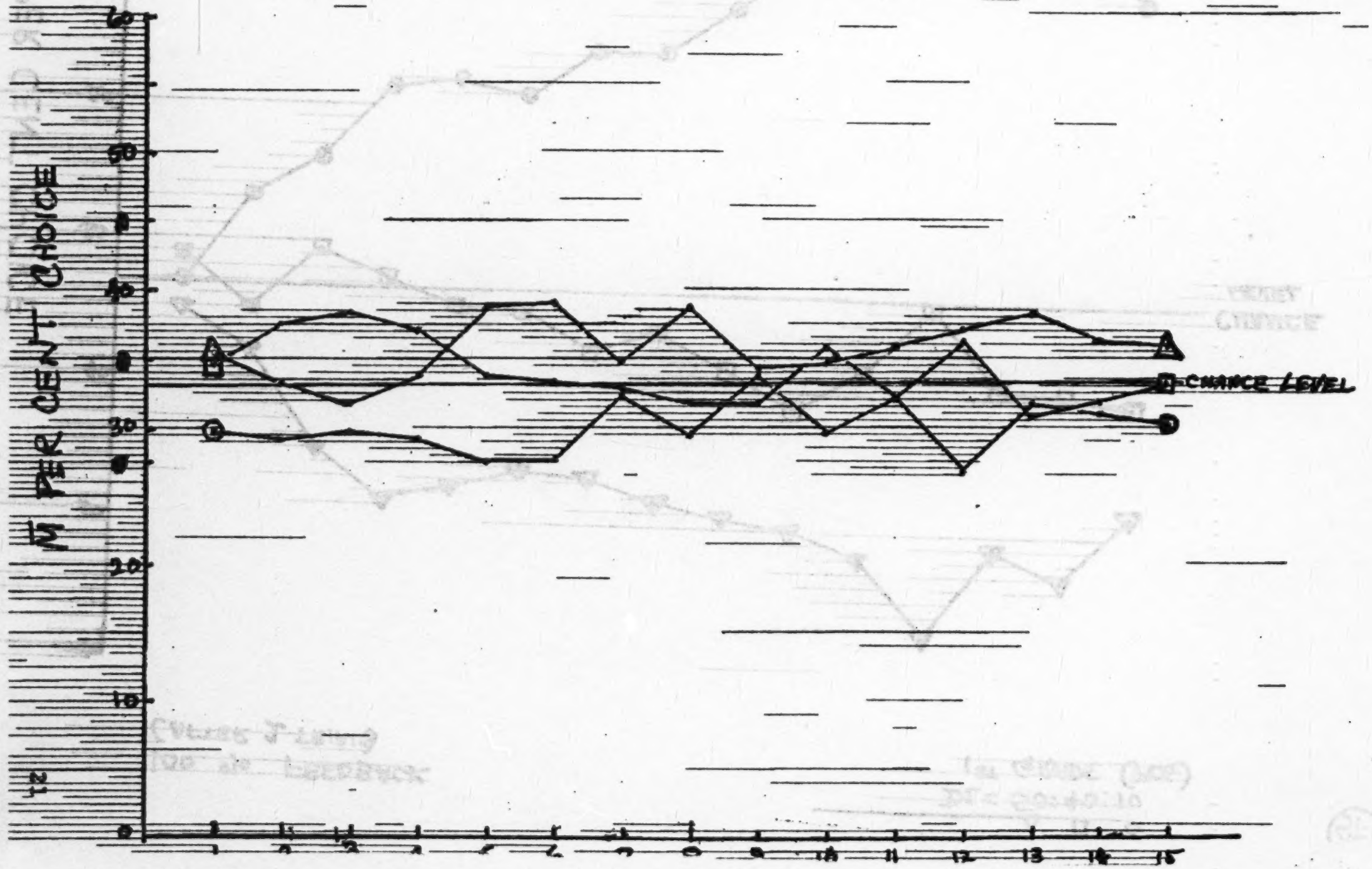
DL 50:30:20
△ □ ⊙

40% FB
5-trial anticip.



DL 50:30:20
Δ □ ○

20% FB
6-Trial anticip.

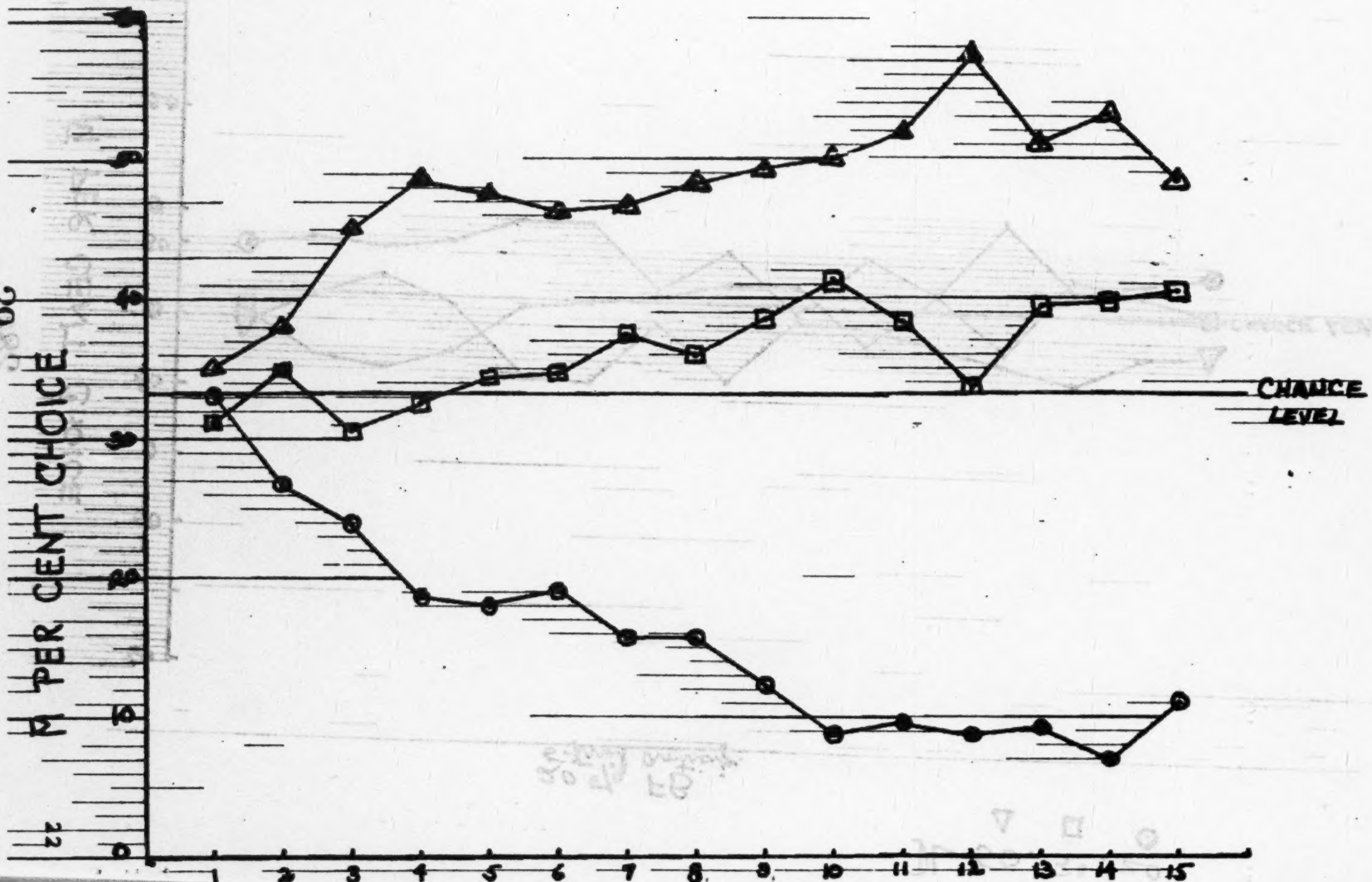


28 82

100 % FEEDBACK
(AFTER 2 TRIALS)

A □ ○
DL = 50:40:10
1ST GRADE (PICK)

(ST-4)



(after 2 trials)

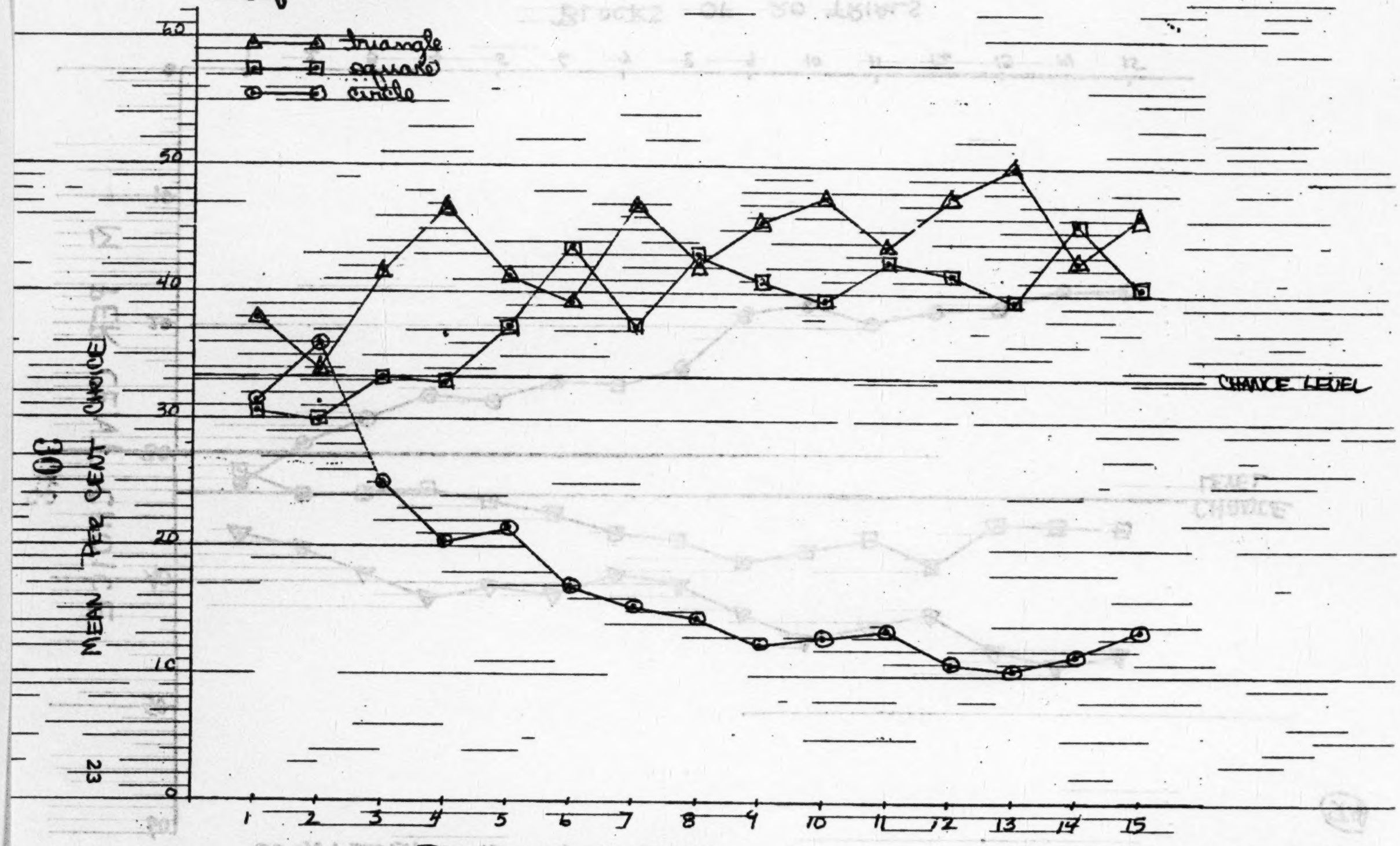
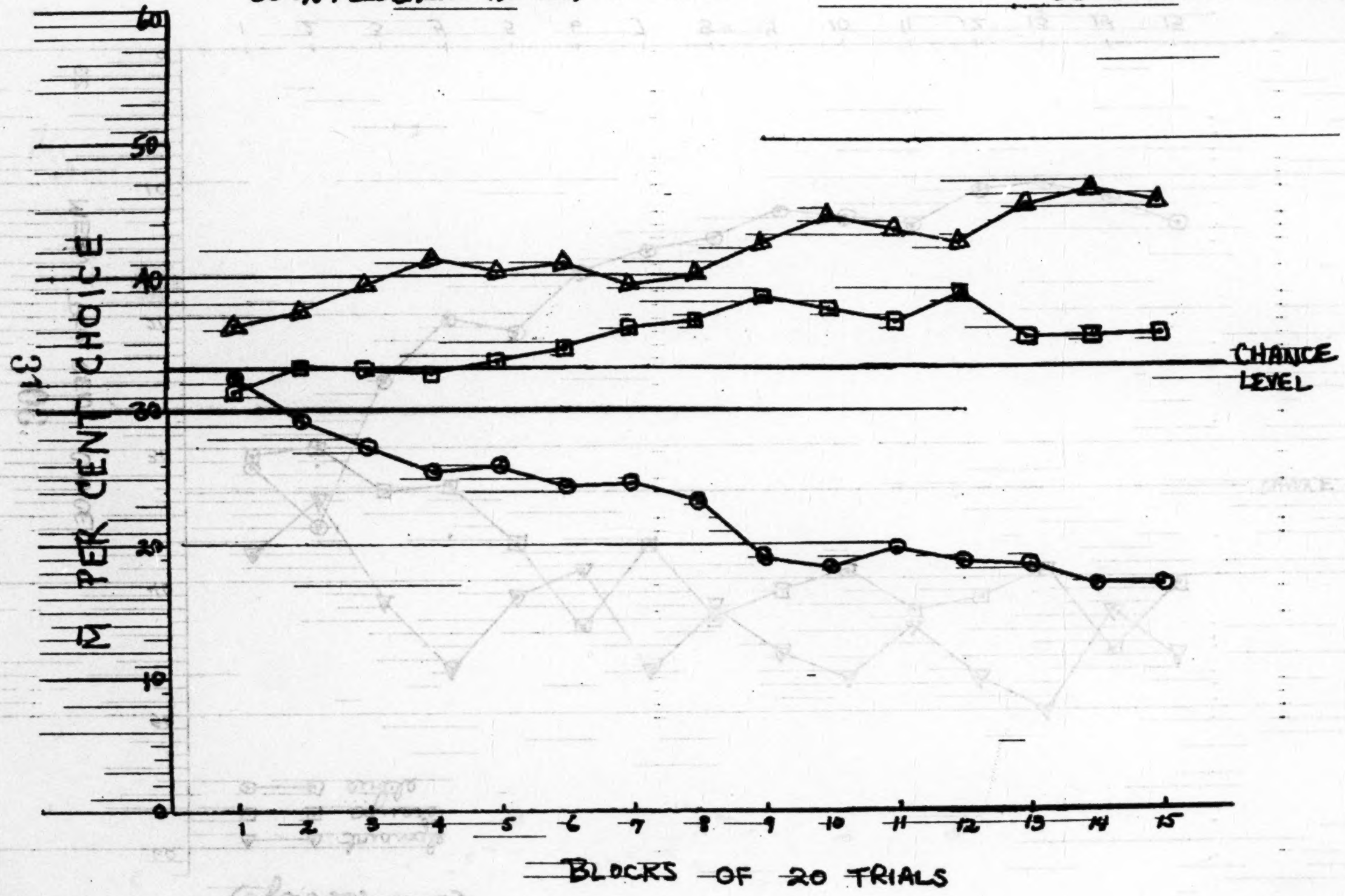


Fig. 7. Mean percentages of choices by Ss of three symbols as a function of successive blocks of the 100% partially reinforced series of trials [illegible]

60 % FEEDBACK (2 TRIALS)

DL = 50:40:10 (1ST GRADE-PO)

(S.4)



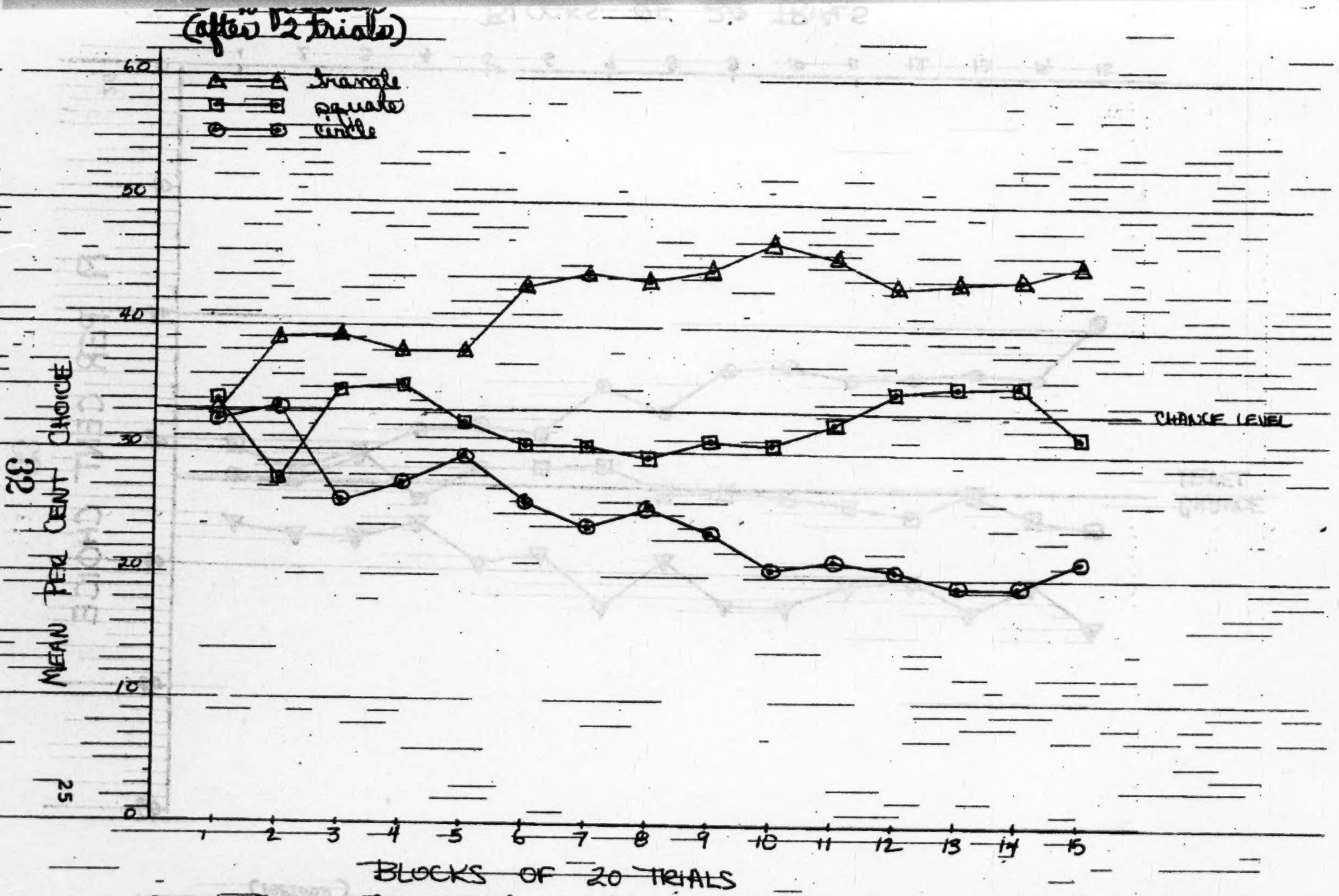
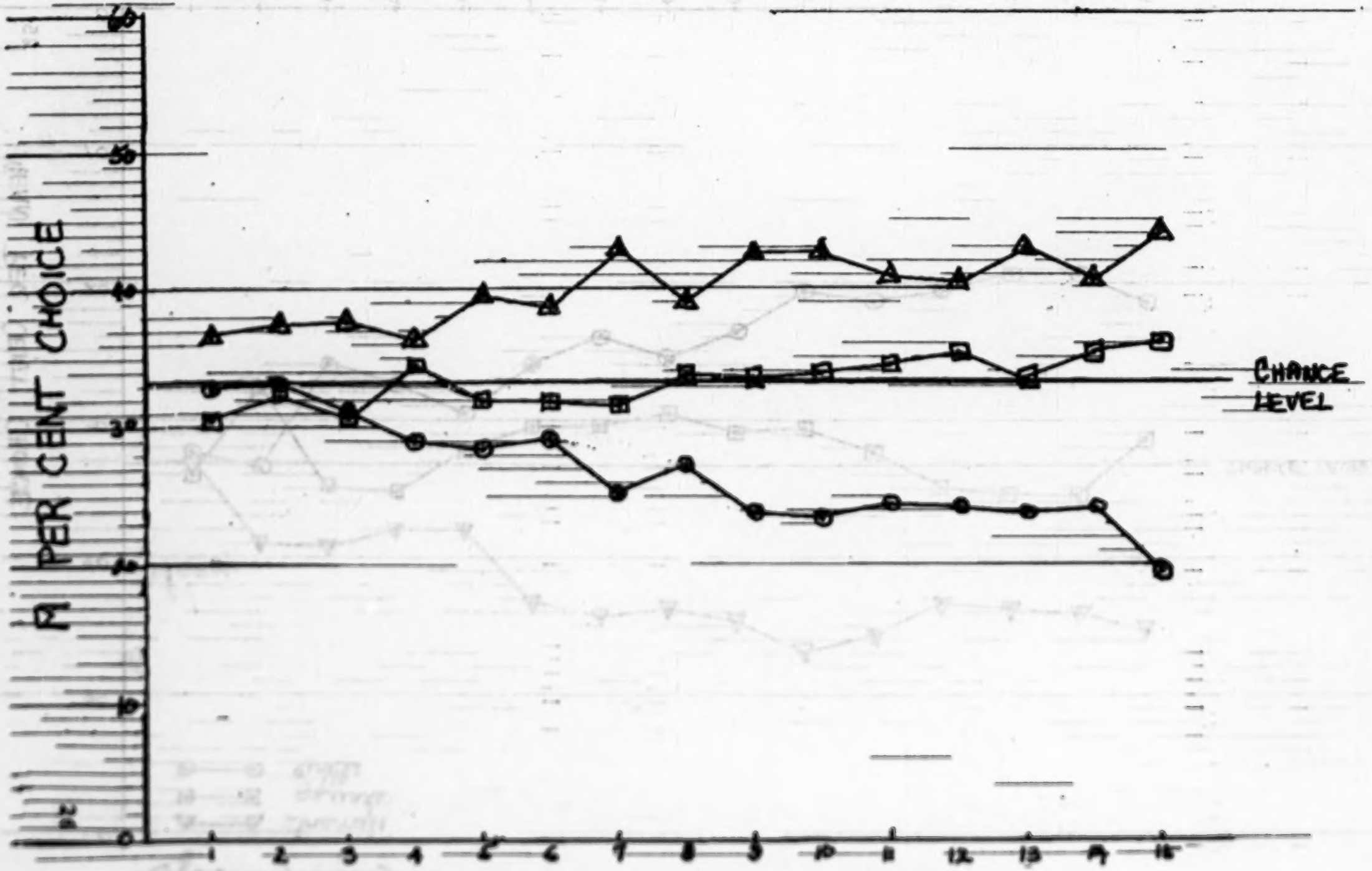


Fig. 4. The percentages of choices by Ss of three symbols as a function of successive trials in the 60% feedback. (After 12 trials condition).

(1-TRIALS ANTICIP METHOD)

(1ST GRADE-PUG)



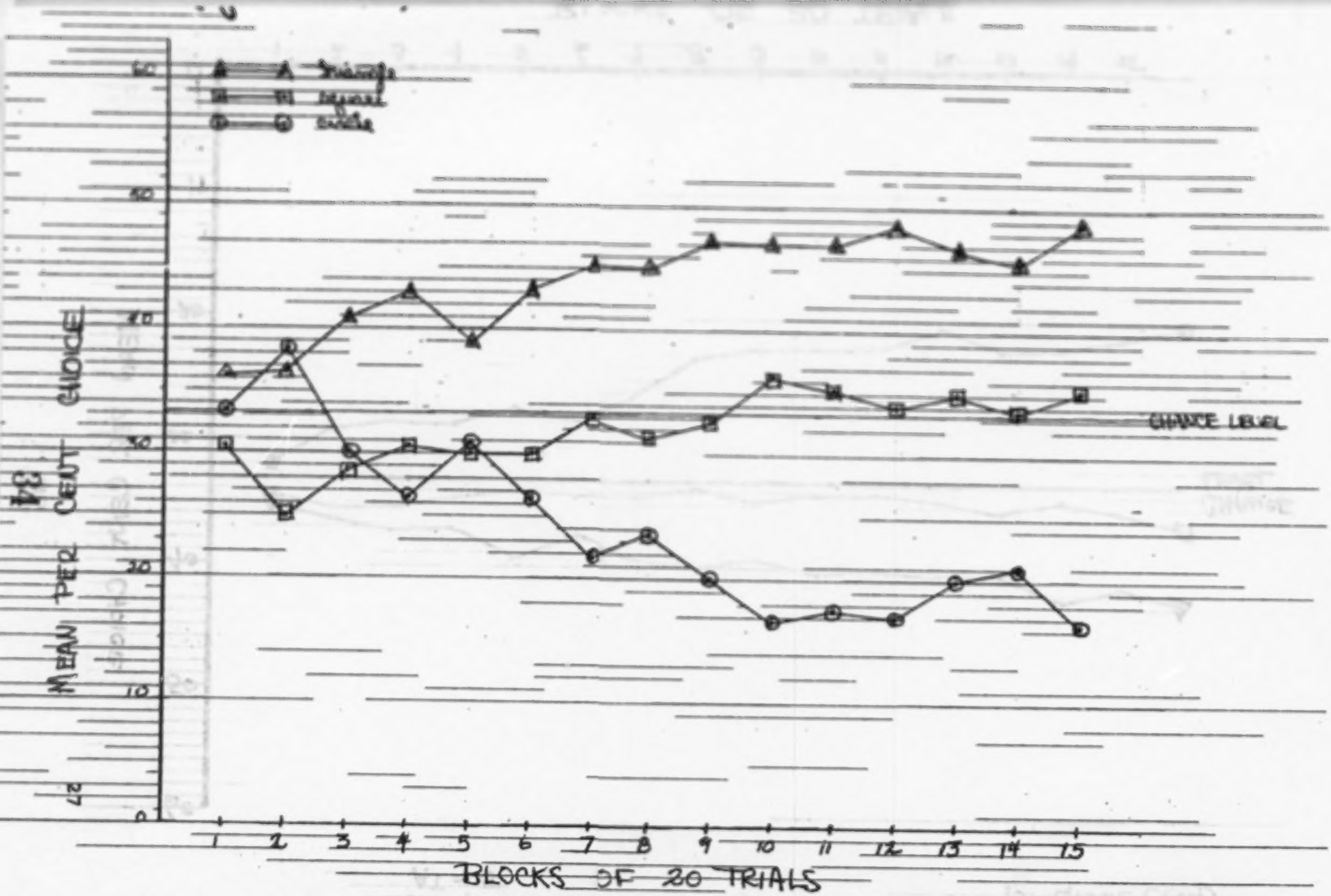
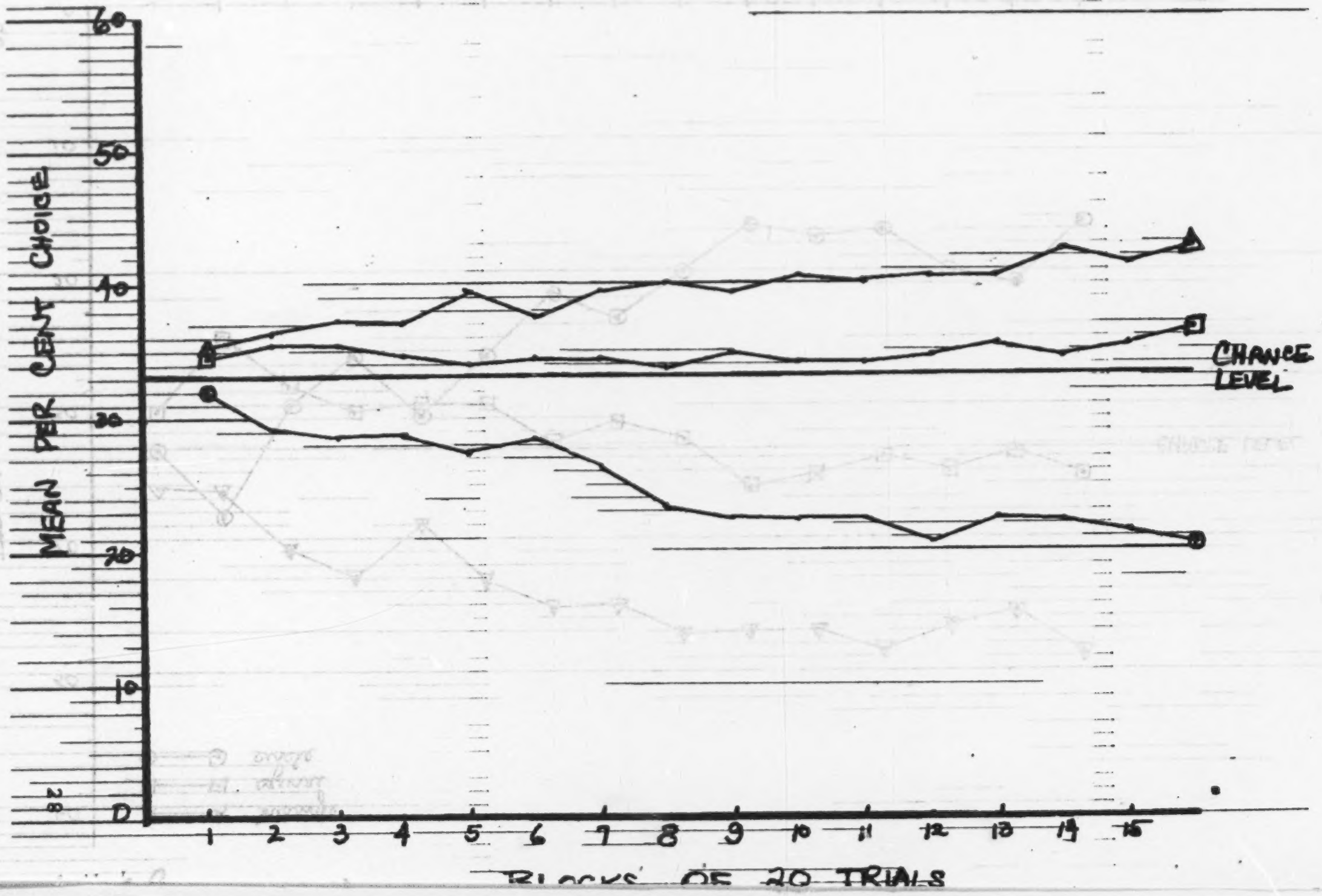


Fig. 1. Mean percentages of choices by Ss of three symbols as a function of successive trials in the 20% feedback after 2 trials condition

100 % IF
AT = 5

DL = 50:40:10
1ST GRADE (PUG)



(after 5 trials)

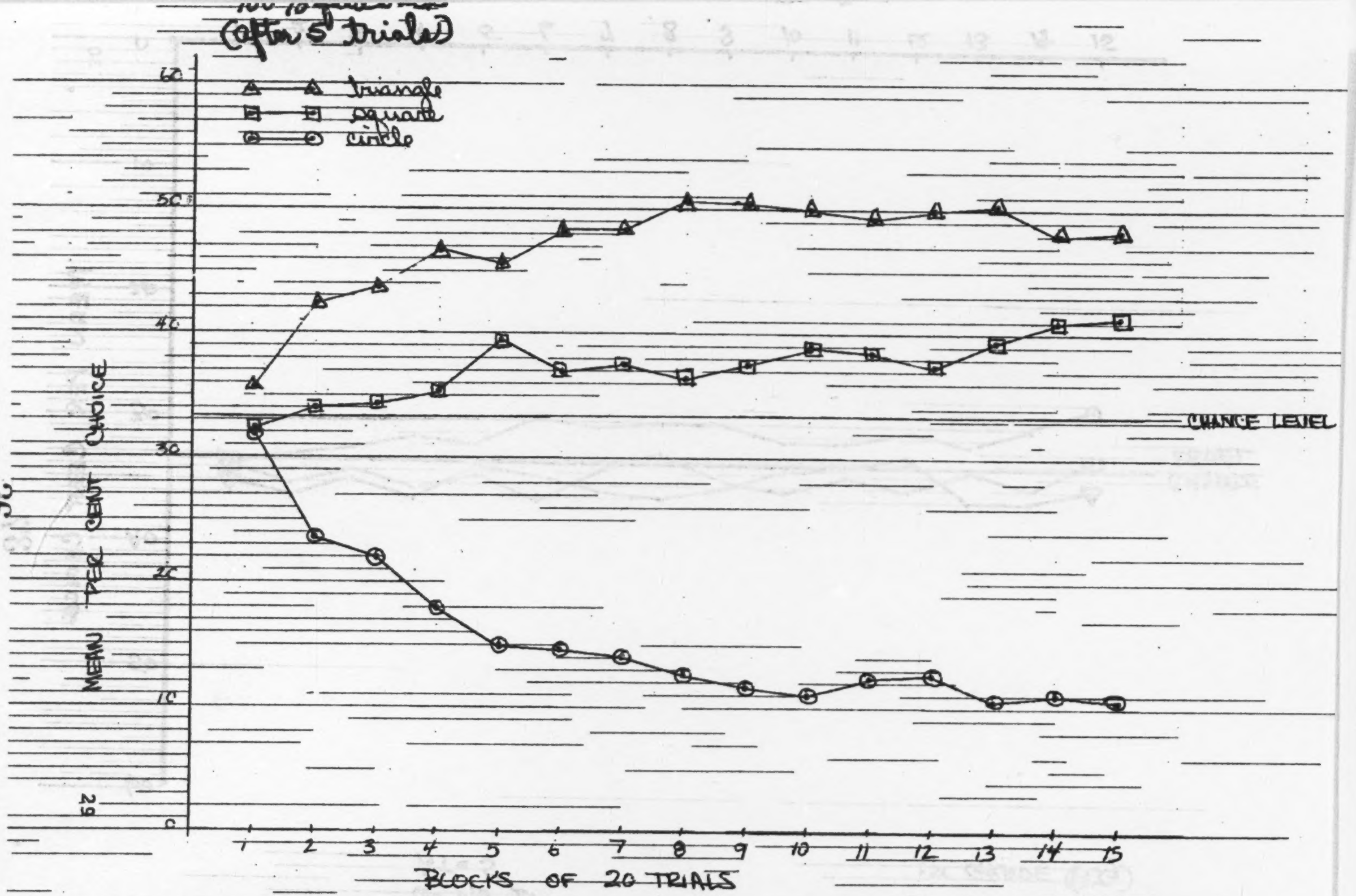
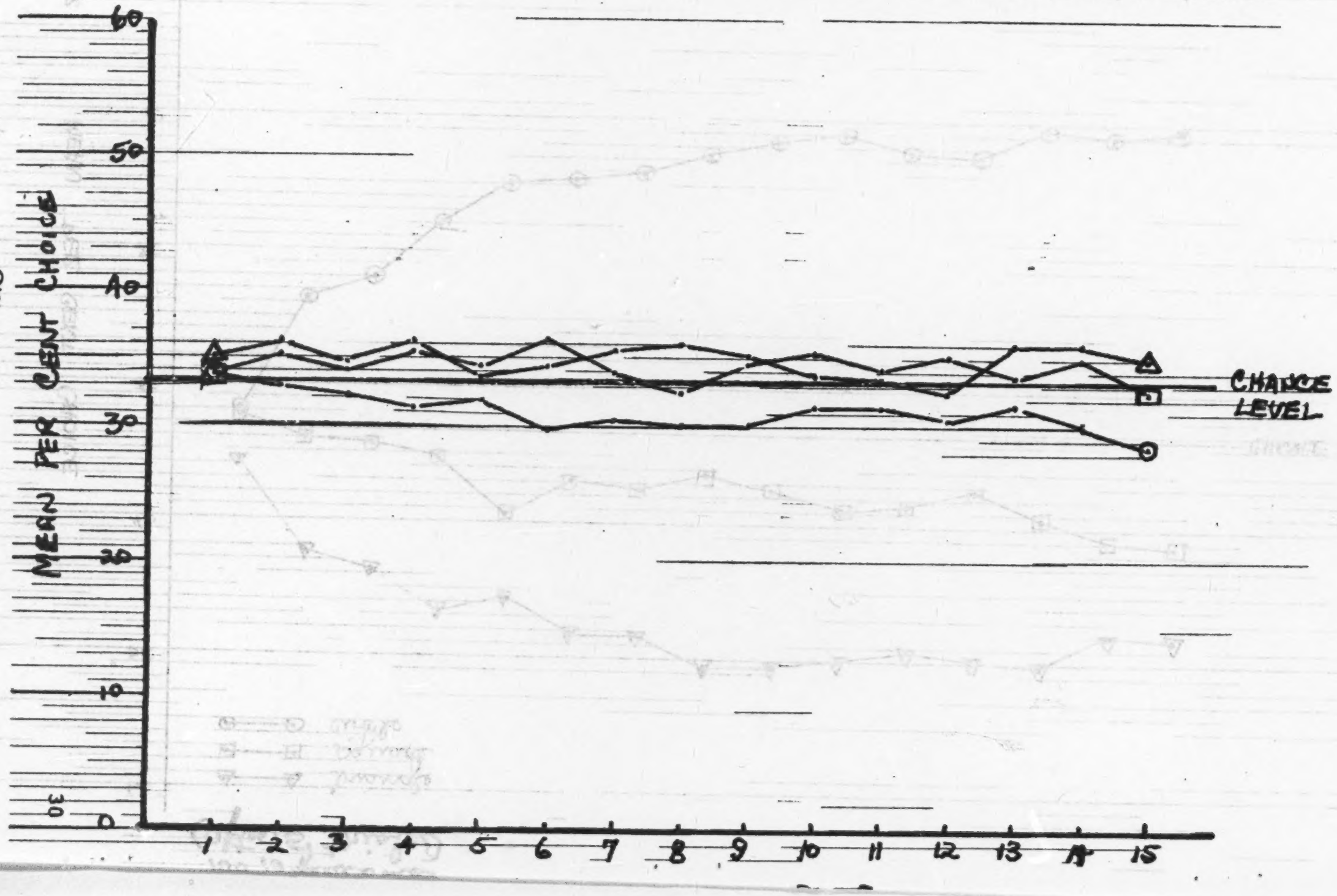


Fig. 8 Ss percentage of choices by Ss of three symbols as a function of successive trials in the 600 after 5 trials condition

60 0/0 IF
AT = 5

DL = 50:40:10
1ST GRADE (RCG)



(after 5 trials)

△—△ triangle
□—□ square
○—○ circle

MEAN PER CENT CHOICE

60
50
40
30
20
10
0

CHANCE LEVEL

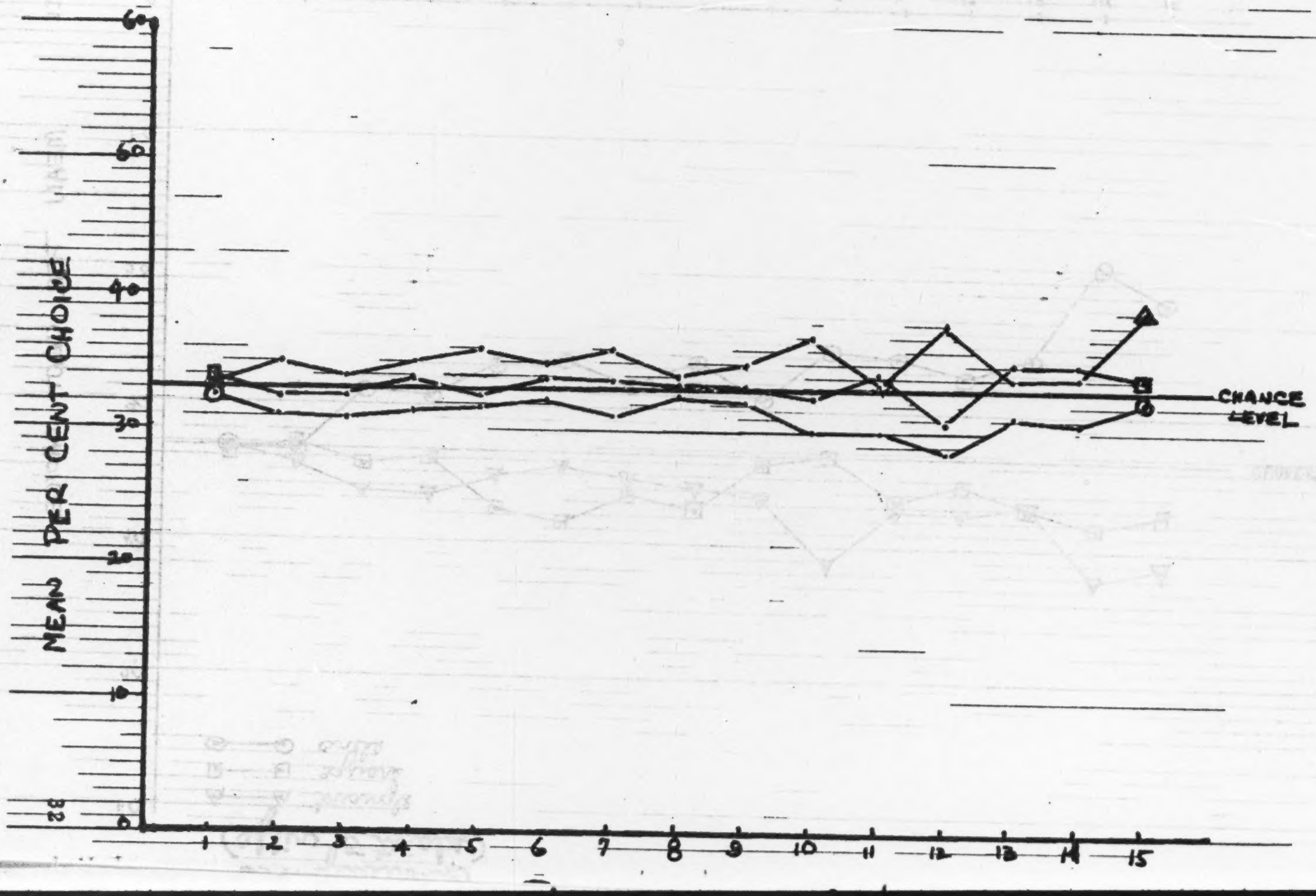
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

BLOCKS OF 20 TRIALS

Fig 5. Percentages of choices by Ss of three symbols as a function of successive trials in the 60% feedback after 5 trials condition.

20 % IF
AT = 5

DL = 50:40:10
1ST GRADE (FCG)



(after 5 trials)

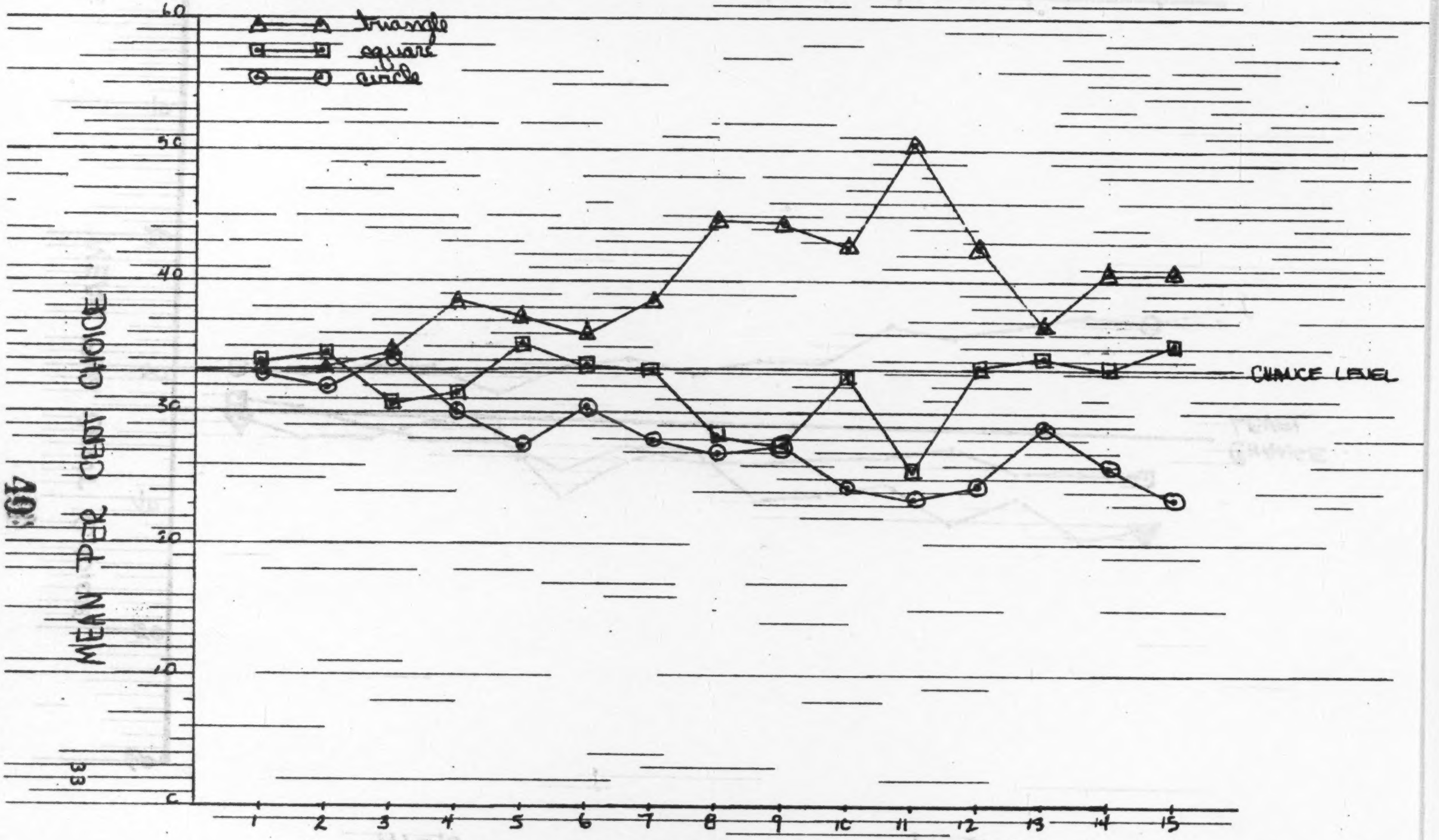
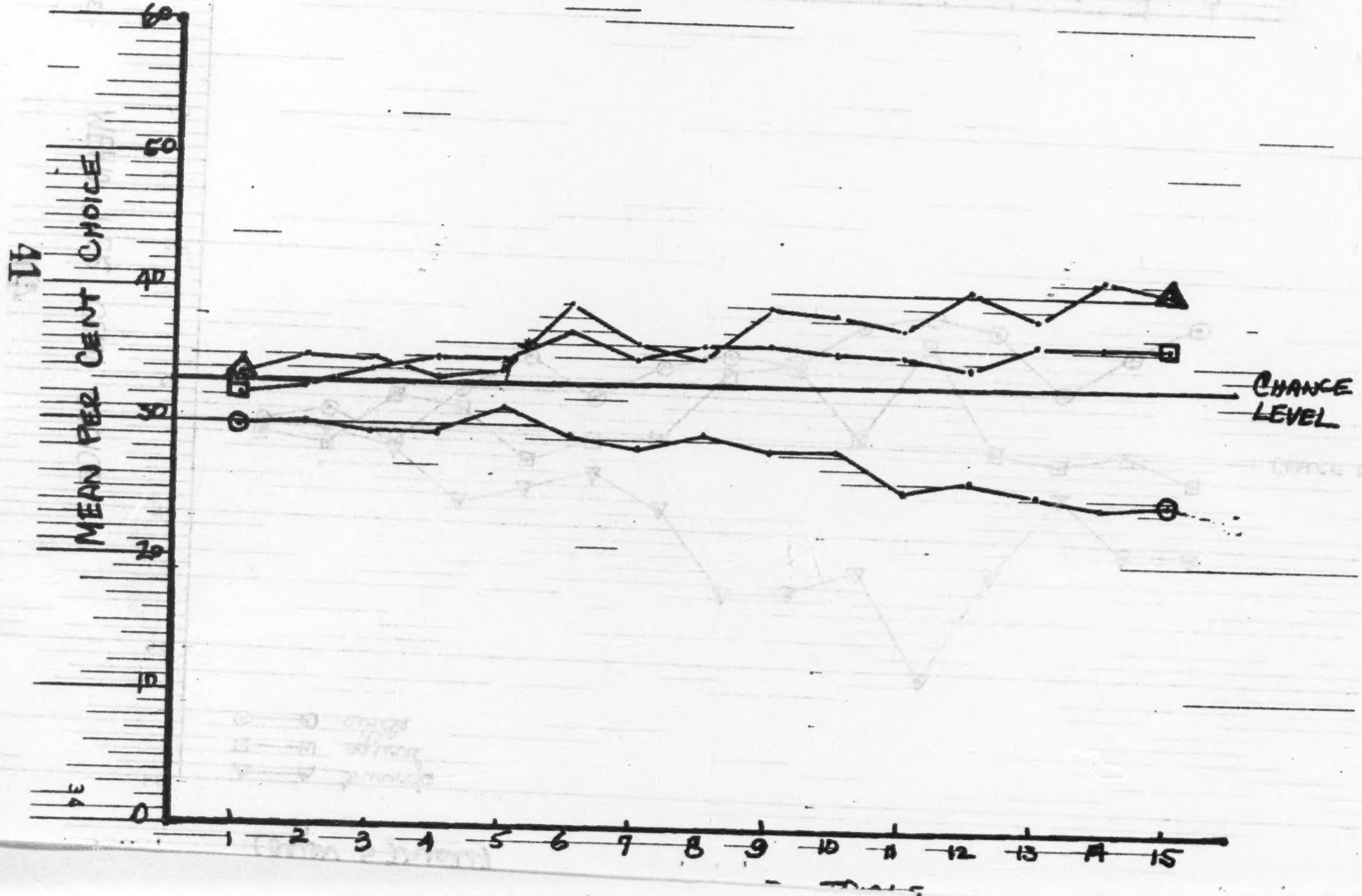


Fig. 2. Th percentages of choices by Ss of three symbols as a function of successive trials in the 20% feedback after 5 trials condition

100 % IF
AT=10

DL= 50:40:10
1ST GRADE (Pcg)



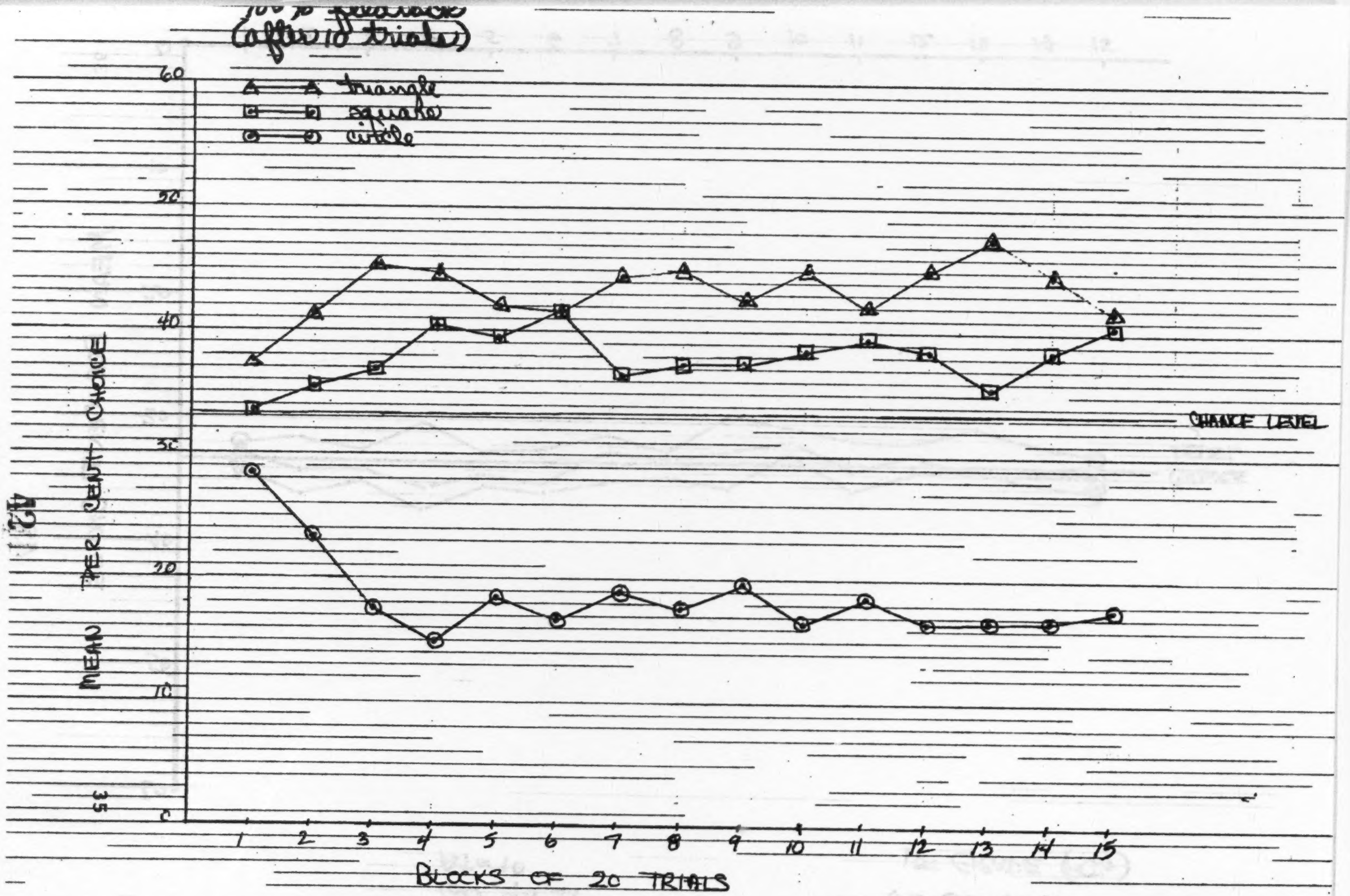
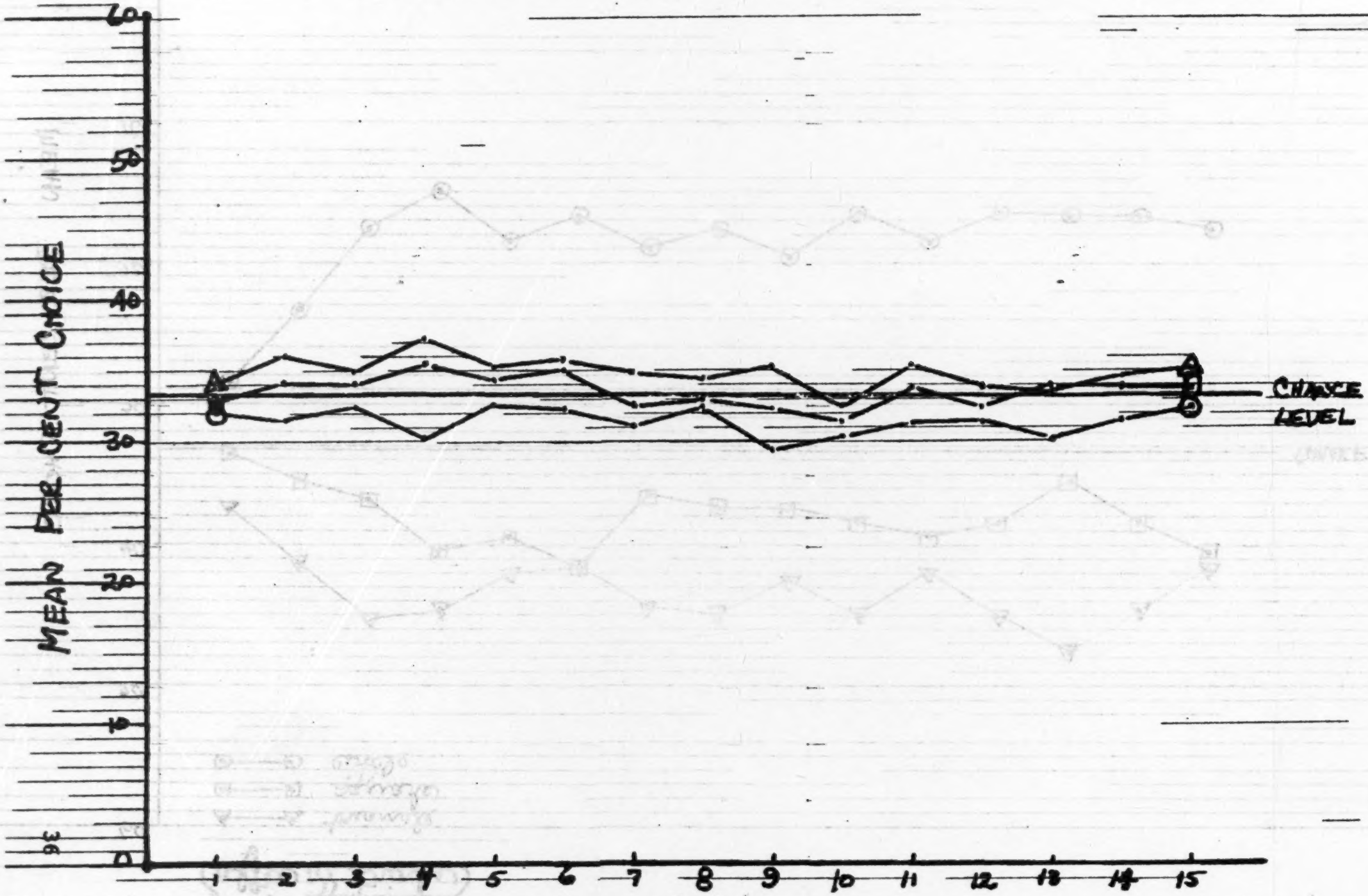


Fig. 9. Mean percentages of choices by Ss of three symbols as a function of successive blocks of 20 trials with feedback after 10 trials (different trials)

60 % IF
AS=10

DL=50:40:10
1ST GRADE (FCY)



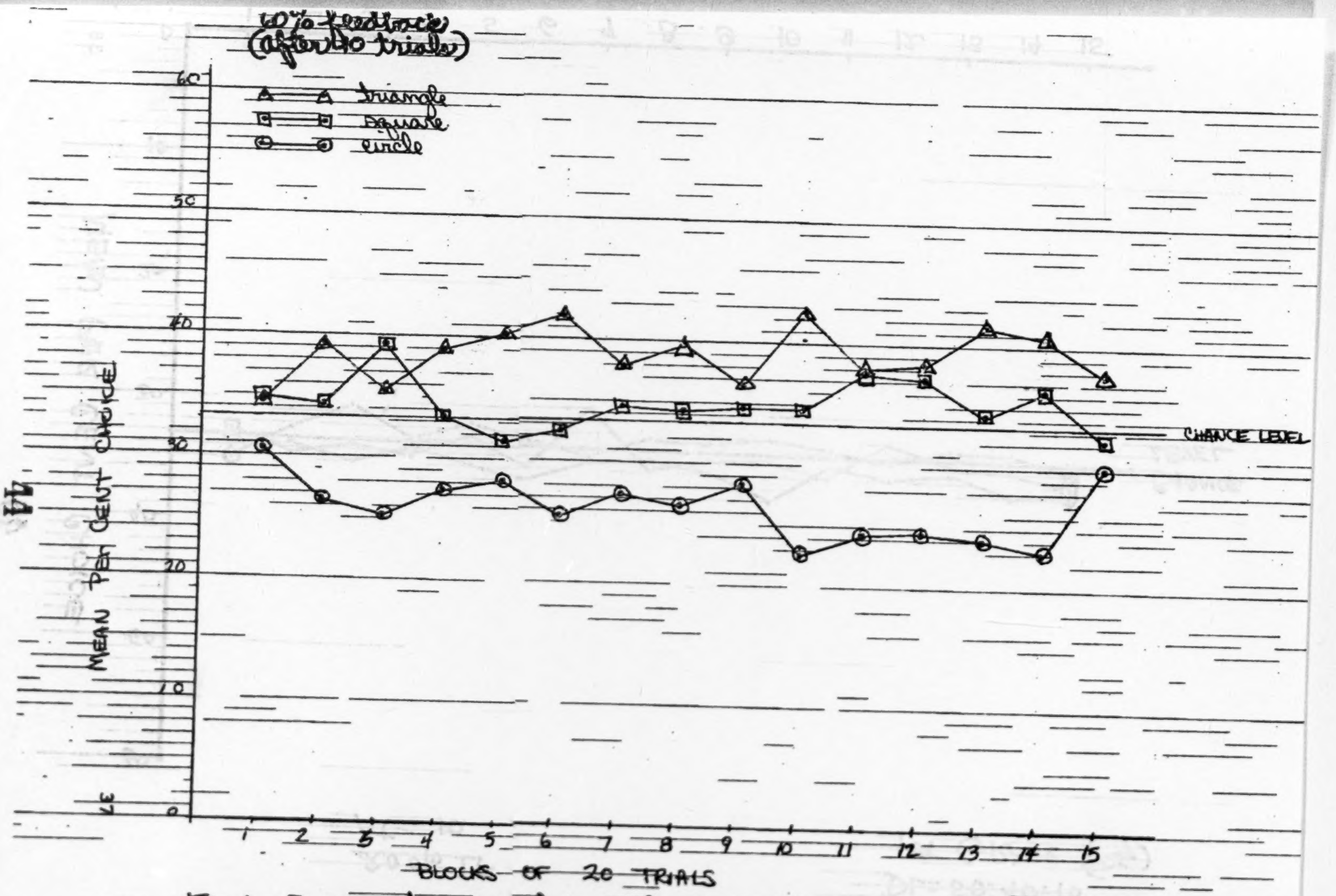
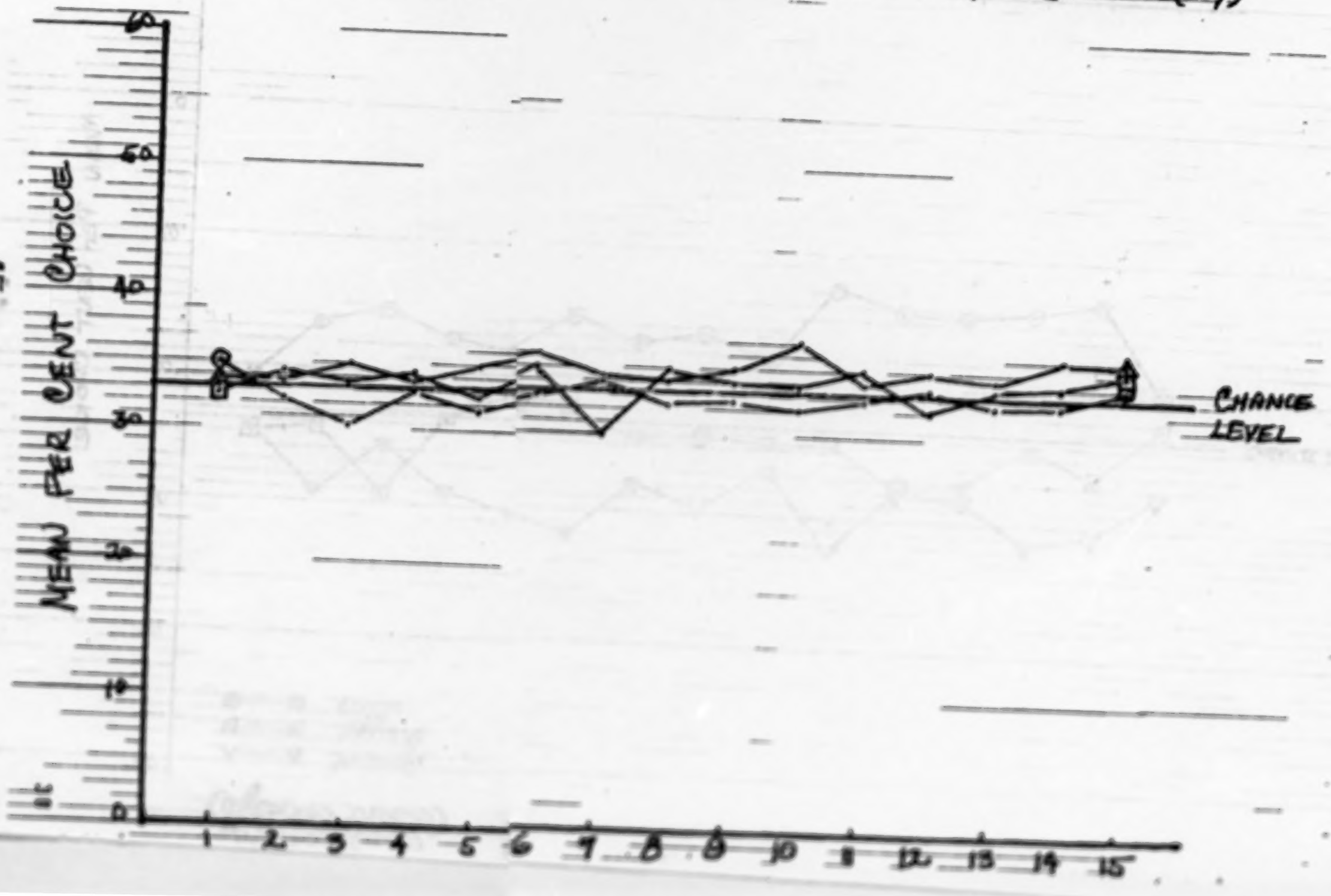


Fig. 6. The percentages of choices by Ss of three symbols act as function of successive trials in the 60% feedback after 10 trials condition.

20% If
At = 10

DL = 50:40:10
1ST GRADE (RG)



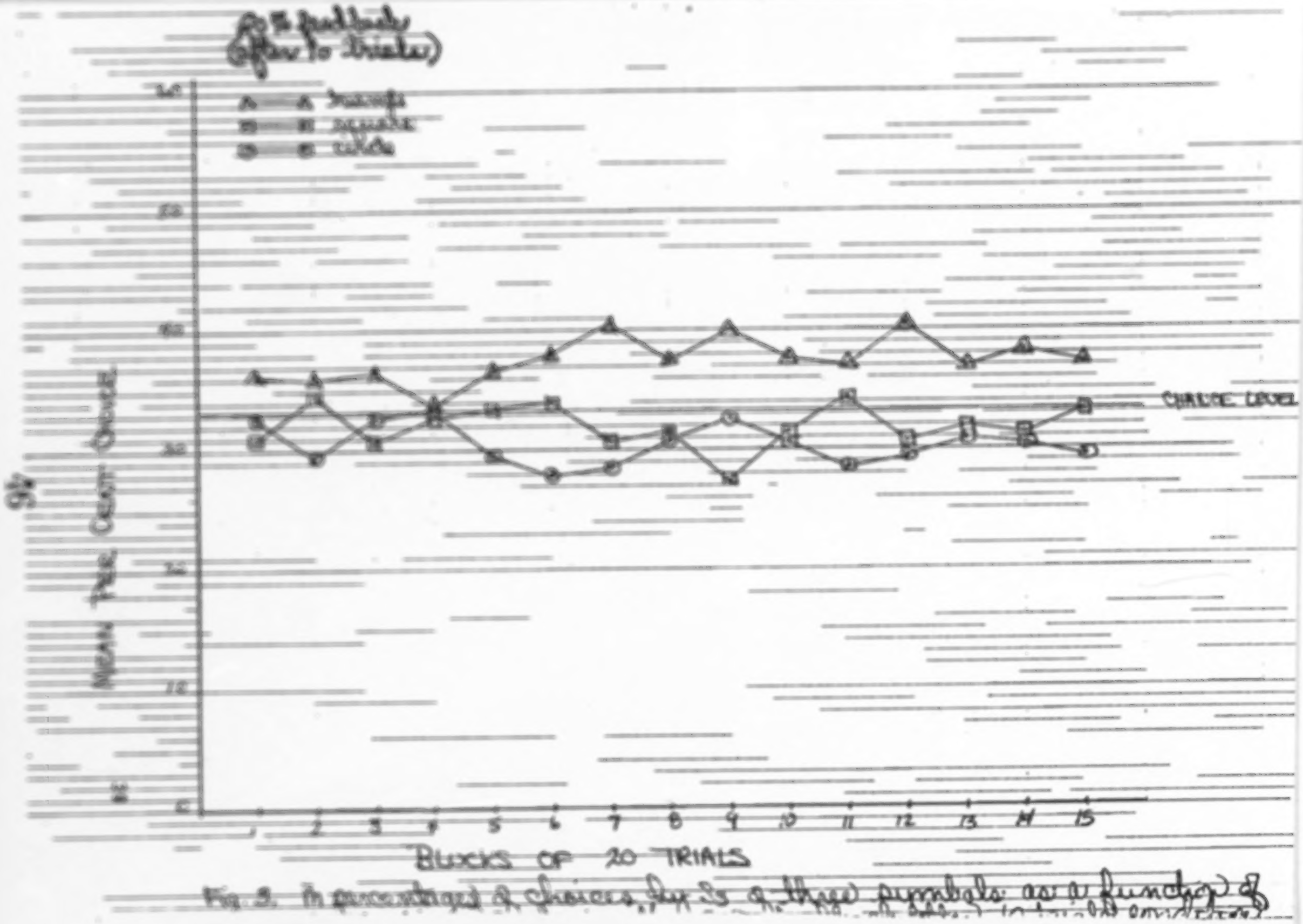


Fig. 2. In percentages of choices for [illegible]